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MARVELS OF CREATION

EARTH AND SEA

FINGAL'S CAVE—INTERIOR. Page 40.

MARVELS OF CREATION:

Earth and Sea.

" Wonderful indeed are all His works,
Pleasant to know, and worthiest to be all
Had in remembrance always with delight."
MILTON.

LONDON:
T. NELSON AND SONS, PATERNOSTER ROW;
EDINBURGH; AND NEW YORK.

1867.

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avalanches, crashing down on many a quiet village-home, and its sudden convulsions, which shake cities into ruin. But these convulsions, whether on land or sea, are due to the working of certain laws, ordained by the Creator in the beginning, and which silently but surely operate throughout all time. We must not be led to regard them as "special judgments" or "displays of the divine wrath." They are irrefragable witnesses to the omnipotence of the Most High; but the agencies which produce them were called into existence at the creation of the world, and are patent to the investigation of the thoughtful observer.

Among those natural phenomena—which excite the reverence of the philosopher no less than the wonder of the clown—pre-eminent in its suddenness, the terrible nature of its consequences, the apparent mystery of its origin, and the awful circumstances which attend its occurrence, must be placed the Earthquake. One scarcely marvels at the perils of the ocean; there is an instability in water, and a want of fixity, which seem consistent with violent and premature changes; but earth appears to the untutored eye so firm, so motionless, so solid, that one is never induced to associate with it any ideas of panic or disaster. The timid, if caught in a storm on the breast of Ocean, longs for "land;" for the shelter of the

rock, for the safety of the quiet valley, the security of the dense wood. He calls it "dear mother Earth"—the impregnable *terra firma*—where, if he can but plant his foot, he will feel himself delivered from every danger. Alas! no ocean calamity can equal in extent the ruin inflicted by a single earthquake! It may be that six hundred lives are annually lost by shipwreck on the coast of Great Britain, but no less than 60,000 men, women, and children perished in the Lisbon earthquake alone! By the great convulsion which shook Calabria to its very centre in 1783, 40,000 persons were destroyed. This was, indeed, a catastrophe of the most terrible character. The changes it wrought, in the apparently solid surface of the earth might reasonably startle the most impassive observer. The soil undulated, we are told, like the waves of the sea, so that many persons felt all the sensations of sea-sickness. Dolomieu asserts that the tops of the tallest trees bowed to the ground, and that the earth seemed to turn round as in a whirlpool. Nothing could resist the violence of these movements. Villas, churches, palaces—all went crashing into utter ruin. The town of Rosarno, planted on an eminence of sand, was completely overthrown; and in the surrounding plain yawned several circular cavities, of the size of a carriage-

wheel. These cavities, like wells, were filled with water to a depth of ten or twenty feet, or with dry sand. In every part of the ground wide fissures were opened, some of which remained unclosed even after the earthquake was over. At Jerocarna the fissures presented a remarkable spectacle, as may be seen in the accompanying illustration: they spread out in all directions, like the radiations of a broken pane of glass. In the course of 75 years—that is, from 1783 to 1857—the kingdom of Naples lost, at least, 111,000 inhabitants by the effect of earthquakes, or more than 1500 per year out of an average population of six millions! Study the following record of a few of the principal shocks which have occurred in the present century, and then determine whether earth or sea—this "visible round world," or the "hollow-sounding and mysterious main"—is man's more implacable foe.

At *Frosolone, Naples*, 6000 lives were lost, July 26, 1805.

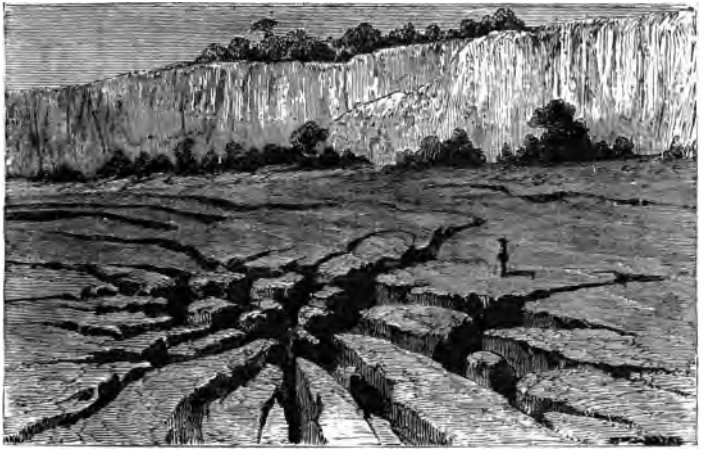
At the *Azores*, a village disappeared, and its place was filled by a lake of boiling water, August 11, 1810.

The city of *St. Leon de Caraccas*, in South America, was nearly overwhelmed on the 26th of March 1812, and upwards of 12,000 persons perished miserably.

In Hindostan, the whole district of *Kutch* sunk several feet below its level, and 2000 persons were buried alive, June 1819.

Thousands were killed in the same month of the same year in *Italy*, and the fair cities of Rome, Geneva, Florence, and Palermo were greatly injured.

Mercia and numerous villages in Spain were devastated by a terrible shock, March 21, 1829. The death-roll numbered 6000.



FISSURES IN THE EARTH AT JEROCARNA.

Calabria suffered severely on the 29th of April 1835, and the 12th of October 1836, upwards of 1000 persons losing their lives on each occasion.

The fertile island of *Ternate* was transformed into a dismal waste, and thousands of lives were lost, February 14, 1840.

On the 2nd of July in the same year, the scourge visited *Mount Ararat*, in one of the districts of Armenia; 3137 houses were overthrown, and hundreds of their unfortunate inhabitants killed.

At *Cape Haytien*, in St. Domingo, an earthquake occurred, on the 7th of May 1842, which overwhelmed two-thirds of the town, and destroyed between 4000 and 5000 human victims.

In the convulsion which blasted *South Italy* on the 14th of August 1851, Melfi was laid in ruins; the episcopal palace, the college, the military depôt, the churches, and 163 houses fell with a mighty crash: other towns and villages suffered in like manner; and the number of killed was estimated at 12,000.

Manilla, the beautiful capital of the Philippine Islands, was nearly destroyed by a succession of shocks, in September and October 1852.

St. Salvador, in South America, was swept away, April 16, 1854.

Broussa in Turkey nearly perished, February 28, 1855; and *Jeddo*, in Japan, November 11.

About 3000 lives were lost by a volcanic eruption and earthquake, at the island of *Great Sanger*, one of the Moluccas, March 12, 1856.

Still more terrible was the catastrophe which befell *Calabria*, and especially the district between La Duchessa and Lagonegro, on the 16th of December 1857. Twenty-two thousand lives were lost in a few seconds! Villages were toppled down like houses of cards, and the sites of once prosperous towns marked by shapeless piles of ruins.

About 5000 persons were killed at *Quito*, March 21, 1859.

Above 1000 persons perished at *Erzeroum*, in Asia Minor, on 2nd of June 1859.

The death-roll swelled to 7000 at *Mendoza*, in South America, on the 20th of March 1861, and two-thirds of the city ceased to be.

At *Guatemala*, 150 houses and public buildings, and 14 churches, were destroyed on the 19th of December 1862.

And a fearful convulsion visited *Manilla*, on the 3rd of June 1863, causing the destruction of 10,000 of its inhabitants.

Nor are earthquakes confined to the tropical world. The whole surface of the Earth is subject

to their destructive influence. They are felt in the extreme north, and in those temperate latitudes which are generally exempt from Nature's more terrible manifestations. It is said that Egypt—the land of sandy deserts and burning skies—has been less afflicted than any other country, but one occurred there in 1740; and several shocks have disturbed the low alluvial deposits of Holland. England has been frequently visited by them, though never severely, except, perhaps, in November 1318, when the consequences were disastrous. According to Mrs. Somerville, about 255 have taken place in our island home, but Comrie, in Perthshire, is afflicted with a slight shock almost every year. Mrs. Somerville refers, of course, only to those which have been historically recorded, but there is little doubt that up to the end of the seventeenth century not above one-twelfth were noted of those which actually occurred. Mr. Mallet, who has bestowed great attention on earthquakes and their causes, asserts that not a day passes without a shock transpiring somewhere, nor any eight consecutive months without one of sufficient force to prostrate buildings over thousands of square miles.

The district most subject to these awful visitations comprises the Mediterranean and the adjacent countries, Asia Minor, the Caspian Sea,

Caucasus, and the Persian mountains. It joins, says Mrs. Somerville, a vast volcanic district in Central Asia, whose chief focus seems to be the Thean-Tchan, which includes Lake Baikal and the neighbouring regions. "A great part of the Asiatic Continent is more or less subject to shocks; but, with the exception of the shores of the Red Sea and the northern parts of Barbary, Africa is entirely free from these tremendous scourges; and it is singular that, notwithstanding the terrible earthquakes which shake the countries west of the Andes, the Andean chain itself, and all the countries round the Gulf of Mexico and the Caribbean Sea, they are extremely rare in the great eastern plains of South America. For the most part the shocks are transmitted in the line of the primary mountain-chains, and seem often to be limited by them in the other direction." They occur most frequently around the centres of volcanic action, and their intensity seems to bear some direct relation to the force and activity of this volcanic action. It seems certain that no volcanic eruption takes place without its being accompanied by an earthquake of greater or less duration and extent. Yet the most violent shocks are not felt in the immediate vicinity of the volcanic fire, but, as at Lisbon, in a region separated from it by a considerable distance.

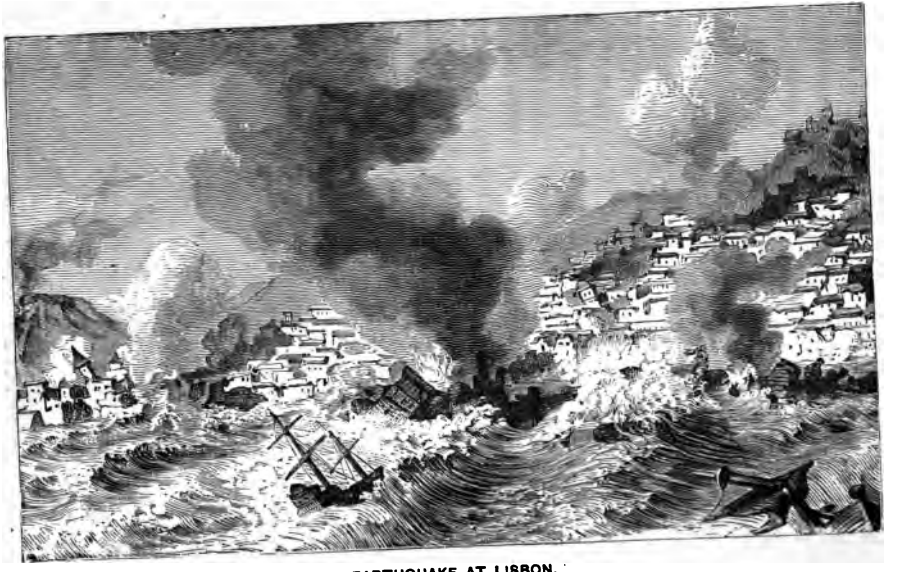
The phenomena connected with earthquakes are various. Generally speaking they are preceded for two or three days by a gloominess in the heaven, and a sultriness in the air; by sudden outbursts of wind succeeded by calms as sudden; by violent showers of rain, which fall with such intensity as to remind men of the days when the windows of heaven were opened on Noah's earth. These signs and portents, however, are occasionally absent; but it is certain that few shocks take place which are not attended or preceded, or both, by strange subterraneous noises, as if the Earth groaned at the misery which was about to fall on her children; or, to use the poet's image, as if she quaked at the approach of her Creator.

> "Her hollow womb,
> Conceiving thunders, through a thousand deeps
> And fiery caverns, roars beneath His foot."

Different observers have recorded different descriptions of these mysterious sounds. By some they are likened to the rattling of chains, gradually swelling into the potency of thunder; by others, to the rumbling of carriages, growing louder by degrees until passing into the deadly roar of artillery; by others, to the hissing produced by quenching masses of red-hot iron in water; and again, by many, to the rush and

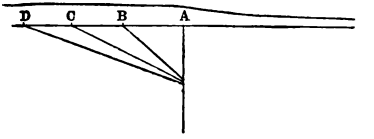
clang of air imprisoned in some subterraneous vault. But sounds are occasionally heard when no earthquake takes place; as on the plains of the Rio Apure, in Caraccas, at the moment the volcano in St. Vincent's, 700 miles distant, poured out a flood of lava. A singular instance is afforded by the "bellowings" of Guanaxuato: these subterraneous noises have been heard for a month uninterruptedly when there was no earthquake felt on the table-land of Mexico, nor in the rich silver mines 600 feet below its surface.

But when these mysterious "voices of omen" accompany an earthquake, the next phenomenon usually observed is a trembling motion of the earth's surface. Then comes a sudden and awful shock, as if the whole fabric of the world were giving way; another, and yet another; followed by a repetition of the tremulous motion, which dies away until it becomes insensible. Sometimes only one shock is felt; sometimes two or three. In the intervals smaller shocks or tremblings will occur; but it is the severe shocks that work disaster. At the centre or focus of greatest disturbance, A, the shock has a distinctly vertical direction, coming from below upwards. Thence, as we leave this point, the motion—the earth-wave as it is scientifically called, or undulation of the crust of the Earth—becomes more



EARTHQUAKE AT LISBON.

and more horizontal, B, C, D, decreasing also in intensity.



Thus, A, being the focus or centre of greatest disturbance, the shock at that point will be vertical and intense, but at B, C, and D, will diminish in violence as it approaches a horizontal direction.

The great earthquake at Lisbon, November 1, 1755, which still finds a place in all our narratives of the wonderful and terrible, exemplified the various earthquake phenomena on a most impressive scale. It had its origin in the bed of the Atlantic Ocean, from whence the convulsions extended over an area of about 7,500,000 square miles, or a twelfth part of the area of the globe. It affected the lofty range of the Alps; broke on the rugged coast of Sweden; spread to the Antilles, Antigua, Barbadoes, and Martinique; was felt in the great Canadian seas, in the recesses of Thuringia, in the plains of Northern Germany, as well as in the small inland lakes that lie near the shores of the Baltic. The force required to propel this enormous earth-wave must

RUINS OF THE CATHEDRAL AT LISBON.

have been colossal; for, suppose the thickness of the terrestrial crust that was thus set in motion did not exceed 20 miles, then 150,000,000 cubic miles must have been moved! In linear distance its effects stretched along a line of 300 miles, the shocks were felt through 2700 miles, and the vibrations or tremors were perceptible in water through 4000 miles. Considering these things, who will wonder at its terrible consequences? Who will marvel that springs ceased to flow, that the sea receded for several furlongs from its accustomed shores, and then suddenly rose to an elevation of fifty or sixty feet? Who will be surprised that houses, cathedrals, churches, and palaces, were shattered in indistinguishable ruin? So awful and mysterious is a convulsion like this—so closely does it resemble an absolute dissolution of the frame of the world, that men's minds when they contemplate it are lost in awe, reverence, and consternation. We may guard against many perils by sea and land; science has done something to defend us against the thunder, the lightning, and the storm; but when the earth suddenly yawns wide at our feet, like a bottomless gulf, we feel that we are powerless—that our boasted strength and intellect avail us nothing—and falling on our knees we can but devoutly exclaim, "Thou art the great God, that

hast made and rulest all things: O deliver us for Thy name's sake!"

The shock at Lisbon lasted only five minutes. It occurred about nine o'clock in the morning of the feast of All Saints, when almost half the population was within the churches; and the fall of these edifices proved fatal to 30,000 persons. The sea retired, and left the bar at the mouth of the Tagus uncovered; then rolled in, like a mountain-wave, full 50 feet above its ordinary level. At Cadiz the waters rose 64 feet; at the Antilles 34 feet, and turned black as jet. At a distance of eight leagues from Morocco, a whole village or town, numbering a population, it is said, of 8000 or 10,000 souls, was suddenly engulfed; the earth opened, like some gigantic mouth, and instantaneously closed over its prey! The loftiest mountains in Portugal were shaken to their very base, their summits cloven into fantastic shapes, and huge masses of rock toppled over into the valleys.

Sir Charles Lyell relates that a new quay at Lisbon, which had been entirely constructed of marble at a great expense, subsided on this occasion. A great multitude of people had gathered there for safety, as to a spot beyond the reach of falling ruins; but lo! in a moment, and without warning, the quay sunk down with all the life,

hopes, fears, and passions crowded upon it; and not one of the dead, whose fate was thus unforeseen and terrible, ever rose again to the surface! They had been entombed in the very depths of the earth. A great number of boats and small craft which had anchored near the quay, and were full of people, were swallowed up as in a whirlpool. Not a fragment of these wrecks was ever seen, and the water which flows over the site of the vanished quay is stated to be one hundred fathoms deep!

What enhances the horrors of these great convulsions is the almost incredible swiftness with which they occur. The earthquake of 1783, in Calabria, which completely changed the face of the country, only lasted two minutes. In the earthquake at Caraccas, March 1812, 10,000 persons perished, yet it consisted only of three shocks, and was over in four seconds. At Peru, in 1746, two hundred shocks were felt in four and twenty hours; Lima was destroyed, nineteen ships in the harbour of Callao were sunk, four were literally flung far up into the inland meadows, and out of a population of 4000 only 200 escaped.

Sometimes, says Mrs. Somerville, a shock has been perceived under ground which was not felt at the surface, as in the year 1802, in the silver

mines of Marienberg, in the Hartz Mountains. In other instances miners have been insensible to shocks felt on the surface above, as at Fahlun, in Sweden, in 1823; circumstances in both instances being influenced by the elasticity of the strata, the depth of the impulses, or obstacles that may have diverted the course of the terrestrial undulation. During earthquakes dislocations of strata take place; the course of rivers is changed, and in some cases they have been permanently dried up; rocks are hurled down, masses raised aloft, the whole face of a country so transformed as to be unrecognized by the native born and bred in its glades; and in a few minutes a metamorphosis is wrought which the most vivid imagination would have been unable to conceive.

What, then, *is* the power which produces these mighty results?

The Hindus tell us it is Brahma changing sides, or the tortoise which supports the world—like Atlas in the classical myth—stirring its flippers. Aristotle ascribed it to a mysterious spirit or air which he called το πνευμα. Later writers have descanted on the sudden imprisonment of the subterranean fires, on the agency of lightning and thunder in the Earth's bosom, on sulphureous and bituminous blasts, on the chemical action of the volcanic elements. The theory now generally

accepted is far more satisfactory than such wide "guesses at truth" as these. We will endeavour to explain it.

To a certain extent the earth is elastic; that is, will transmit a shock or pulsation in all directions from the point at which it is struck. If you place your ear to the surface of a line of railway you can hear the motion of the train approaching from a considerable distance. In like manner the earthquake-wave is propelled over an extended area. It starts from a given point, where some violent shock or blow originates it, and rolls onward in various directions, lessening in force as it spreads further and further from its point of departure. We know that this is the case with waves of sound—that at three hundred yards we hear less distinctly than at one hundred, and so on.

Most great earthquakes have their origin in the bed of the ocean, far from land, whence the shocks travel in undulations to the surrounding shores. There are, then, two kinds of waves or undulations produced and propagated simultaneously: one through the bed of the ocean, which is the great earthquake shock; and another on the surface of the ocean, which rolls to the shore, and reaches it in time to complete the destruction long after the principal wave through the solid

ocean-bed has arrived and spent itself on the land.

"Three other series of undulations," says the eloquent writer already quoted, "are formed simultaneously with the preceding, by which the sound of the explosion is conveyed through the earth, the ocean, and the air, with different velocities. That through the earth travels at the rate of from 7000 to 10,000 feet in a second in hard rock, and somewhat less in looser materials, and arrives at the coast a short time before, or at the same moment with, the shock, and produces the hollow sounds that are the harbingers of ruin; then follows a continuous succession of sounds, like the rolling of distant thunder, formed, first, by the wave that is propagated through the water of the sea, which travels at the rate of 4700 feet in a second, and, lastly, by that passing through the air, which only takes place when the origin of the earthquake is a submarine explosion, and travels with a velocity of 1123 feet in a second. The rolling sounds precede the arrival of the great waves on the coasts, and are continued after the terrific catastrophe when the eruption is extensive."

Our readers now will understand, we think, that the earthquake shock is produced by a wave or undulation starting from a given focus—a wave

of elastic compression, says Mallet, passing through some portion of the substance of our Earth. But what produces the *wave?* will be their next inquiry. Here our philosophers are somewhat puzzled. Mr. Mallet, a great authority on earthquakes, ascribes it to an irruption, or breaking forth, of igneous matter beneath the sea-bottom, which in the first place opens up large fissures in its rocky material, and elevates and removes its sand, mud, or gravel. The water meeting with these heated surfaces assumes a spheroidal shape, as it does when poured on red-hot iron. While in this condition the intestine motion may be great, but little steam is generated, and no impulses will be conveyed to a distance except the *tremblings* which precede the shock; but as soon as the surfaces cool, and the water comes into close contact with them, a vast volume of steam explodes and is blown off into the deep cold water of the sea, where it condenses, and thus a tremendous blow is given at the volcanic focus, which spreads its influence in all directions as the earthquake-shock. Of course, as the surfaces cool down, the steam ceases to be generated, the tremblings become less violent, and gradually disappear.

On the other hand, Professor Rogers puts forward a somewhat simpler hypothesis. It is agreed

that the centre of the Earth is occupied by a molten fluid mass in a state of ebullition. Well, he conceives the producing cause of the earthquake to be a *pulsation* of this mass of fluid, propagated in the manner of waves or undulations, from enormous ruptures, and floating forward on its surface the superimposed rocky crust of the Earth.

Less destructive, because less universal in their effects than earthquakes, but closely connected with them in origin, are Volcanoes, which occupy a prominent place among the more fatally violent of terrestrial agencies. Their explosions or outbursts are attended with peculiarly awful circumtances, as if designed by Providence to produce a powerful and lasting influence on the human mind. Hence, like earthquakes, they were considered in the olden days of ignorance and superstition to be direct manifestations of the divine wrath. But it may reasonably be doubted whether we should not rather regard them as evidences of the divine love and wisdom. As the interior of the Earth is ever in a molten state, and consequently generating potent explosive gases, it is probable that but for the vents or safety-valves provided by volcanoes, the fabric of our globe would be shattered into utter ruin. The desolation which in an earthquake is *local* would then become *universal.*

Moreover, as Sir Charles Lyell points out, they act as a compensating force against water. Running streams and encroaching ocean-tides are constantly wearing down the high places of the Earth, and it is necessary—to preserve a general equilibrium—that the volcanic explosion should fill up the valleys and shatter the mountains; should accumulate in the hollows its igneous material, or with its lava-floods elevate the low-lying plain.

A volcano is a rent or fissure in the Earth's crust, through which, at uncertain intervals, the igneous forces of the interior world discharge greater or lesser quantities of liquid lava, masses of rock and molten matter, showers of ashes and stones, and even of boiling water, accompanied by volumes of gaseous vapour and dense smoke. The aperture through which these discharges are effected is called a *crater*, because it is generally shaped like a cup or basin, and this crater usually occupies the summit of a mountain. Feebler efforts of the volcanic force, which proceed from chinks or crannies in the surface of the ground, are named *solfataras*. Hot springs, springs of naphtha and petroleum, and various kinds of gas, as carbonic acid gas, are also indications of volcanic action. There are several volcanoes which emit only streams of boiling water, as the Volcano

de Agua in Guatemala; others pour forth boiling mud, as in the islands of Trinidad, Java, and Cheduba in the Bay of Bengal. When a volcano ceases to eject vapour or volcanic products it is said to be *extinct;* for the seat of activity is perpetually changing, and volcanoes which broke forth in violent eruptions centuries before the Christian era, have long ceased to exhibit the power of the internal fires.

Altogether about 270 active volcanoes are known to exist, and of these 190 are disposed along the shores or in the islands of the Pacific. It is noticeable that isolated volcanoes are rare; they generally occur in lines or groups. One of the most remarkable of the volcanic "belts" is that of the chain of the Andes, which, from north to south, forms a mighty region of igneous action, including Chimborazo, Chinchincha, Cotopaxi, Antisana, Orizaba, and other "fire-breathing heights." Another belt may be traced across the Pacific Ocean through the Polynesian Archipelago, especially the Sandwich Islands, the New Hebrides, and the Friendly Islands. A third chain begins in Kamtschatka, and strikes through the Aleutian Isles, the Kurile, Japan, the Philippine Islands, the Moluccas, Java, Sumatra, and Borneo, to the Bay of Bengal. So, too, you may trace a distinct volcanic belt from the Azores across the

Mediterranean to the Caspian Sea. Iceland is a remarkable centre of igneous activity; and the Peak of Teneriffe, encompassed by the volcanic islands of Palma and Lancerota, furnishes an admirable example of a volcanic group. Eruptions, we may add, are much more frequent in low than in high volcanoes. That in the Island of Stromboli, in the Mediterranean, is perpetually burning; whereas Cotopaxi, 18,775 feet high, and Tungaragua in the Andes, have only been active once in a hundred years. So great a force is requisite to elevate lava to a considerable altitude, that it rarely flows from very lofty cones. Antisana is said to be the single instance to the contrary among all the lofty volcanoes in Quito; while in Etna the pressure is so immense that the fire-flood will force its way through the solid flanks of the mountain, or emerge at its very base.

Probably no spot of the same size on the face of the Earth contains so many volcanoes as the Island of Java. A range of volcanic mountains, from 5,000 to 13,000 feet high, forms the backbone of the island, and terminates to the east in a series of thirty-eight separate volcanoes, rising from broad bases into lofty tapering cones. They all stand on a plateau but little elevated above the sea, and each individual mountain seems to have been formed independently of its fellows.

Most of them are of hoar antiquity, and their sides, from base to crest, are luxuriantly clothed with vegetation. Some are extinct, or only emit clouds of smoke; one has a large crater brimful of ebullient water; sulphureous vapours issue from another with terrific violence; and a few break out into terrible eruptions at frequent intervals. In 1772 the greater portion of one of the largest volcanic cones was swallowed up "after a short but severe combustion:" on the 11th of August a luminous cloud enveloped it like a mantle, and soon after the huge mass disappeared under the earth—disappeared bodily—with a fearful crash, and carried with it "into the jaws of darkness" about 90 square miles of woodland, meadow, and garden, with 40 villages, and nearly 3000 of their inhabitants!

Another great centre of volcanic action is the Sandwich Islands, where the volcanoes of Hawaii are inferior to none in the sublimity of horror. That of Kilauea is situated on the flanks of Mauna Loa, which is itself a volcano, and attains an elevation of 13,760 feet above the sea. It is described as a double caldron of fire, or two lakes of boiling lava, surrounded by masses of volcanic product which have formerly been in a state of fusion. These glaring lakes are ever boiling furiously! Occasionally their seething

billows leap to the height of from twenty to seventy feet; and streams of lava, hurrying along in waves of fire and vapour, are precipitated down an ignited arch; and the turmoil, and the seething, and the hissing, and the roaring, continue day by day and night by night; and the heat is that of ten thousand mid-day suns; and the dryness of the air is so intense as to scorch the eyelids of the spectator; and the noise seems to deafen him, and to equal the roar of all the artillery ever brought together in human battles!

In Iceland — that solitary isle of frost and eternal snows, where you would think the Genius of Fire would never have found a resting-place— volcanic eruptions of extraordinary violence frequently occur. The island is, in fact, one entire volcanic mass. Under its crust of ice the igneous forces are ever active. From north to south, and east to west, may be found smoking mountains, mines of burning sulphur, springs of boiling water, and jets of hissing vapour—all surrounded and hemmed in by frozen deserts and dreary levels of untrodden snow! Many of those cones which pour out rivers of fire are *jokuls*, or mountains whose snowy brows are eternally crowned with their diadems of frozen brightness. Their dimensions, moreover, are enormous. Etna is estimated to be 180 miles in circumference, but

if both Etna and Vesuvius were flung into the yawning crater of Skapta Jokul they would not fill the void!

We have spoken of streams of lava, and our young readers will probably ask, What *is* lava? It means a stream or river of molten matter poured forth from a volcanic aperture, either by land or water. It is composed of various materials, all fused together by the vast heat of the internal fires of Earth, and, as it cools, congeals into a solid substance.* The interior mass, however, retains its heat for a considerable period, and so permits the stream to flow continuously, carrying with it its hardened crust or surface, for a greater or lesser distance. The lava-flood that issued from the Skapta Jokul divided into two channels, one of which measured twelve to fifteen miles wide and fifty miles in length, the other seven in width and forty in length, while both averaged a depth or density of one hundred feet! Fancy the River Thames, from London Bridge to the Nore, with its channel widened out some thirteen or fourteen miles, and filled with a mass of burning matter, which, as it slowly moved along, should hiss and seethe, and send off clouds of unwholesome gases;—can you conceive any

* For a fuller account of "Volcanoes and Volcanic Phenomena," the reader is referred to the volume under that title published in the present Series.

scene more awful, or more impressive in its dread sublimity? Such are among the phenomena of Nature—among those wonders which surround us on every hand; which too frequently are regarded with comparative indifference, but which should awaken in every thoughtful mind a living sense of the power, wisdom, and majesty of the Creator. Surely Nature, as Carlyle has said, is the time-vesture of the Almighty, that reveals Him to the wise, and hides Him from the foolish.

"In contemplation of created things,
By steps we may ascend to God."—MILTON.

AUTHORITIES.—Sir C. Lyell, *Principles of Geology;* Mallet, *Report to the British Association;* Humboldt, *Cosmos;* Dr. Daubeny, *On Volcanoes;* Mrs. Somerville, *Physical Geography;* &c.

II.

Caverns and Deserts.

"The sultry sun had gained the middle sky,
And not a tree, and not a herb was nigh:
The beasts with pain their dusty way pursue;
Shrill roared the winds, and dreary was the view."

COLLINS.

IN what is called Juvenile Literature, it must be owned that Caverns play a conspicuous part; and in the dreams of boyhood, I fancy, they oftentimes figure as the scene of adventures and enchantments, in which the dreamer invariably acts the hero. The cavern of our boyish imaginations, however, is widely different from the cavern of reality. We base our conceptions on the wondrous story of Robinson Crusoe, whose cave, in his lonely island, was a masterpiece of nature and art. Or perhaps our ideas are suggested by the treasure-cave in the Arabian Nights, which gave up its spoils to the audacious Ali Baba at the utterance of the magic words, "Open, Sesame." There is a marvellous cave described in the veracious narrative of

"Peter Wilkins," where he and his bride, the winged woman, make their abode in love and happiness. Does not Sinbad the Sailor find an asylum in a cavern, after he has discovered the monstrous roc? It was in one of these dark, obscure recesses that Ulysses extinguished the solitary eye of the horrid Polyphemus, and so escaped from the jaws which had devoured his companions.

> "The one-eyed children of the ocean god,
> The man-destroying Cyclopses, inhabit,
> On this wild shore, their solitary caves."
>
> EURIPIDES.

Older readers will remember the cave in which Balfour of Burley, in Scott's novel of "Old Mortality," secretes himself from his pursuers, and to which access is only gained, across a terrific chasm, by means of "an old oak-tree, forming a bridge of fearfully narrow dimensions and uncertain footing." The Scotch Covenanters, in the fierce days of religious persecution, usually sought an asylum in secluded caves—as at Creehope Linn, near Closeburn—"where they had not only to struggle with the real dangers of damp, darkness, and famine, but were called upon, in their disordered imaginations, to oppose the infernal powers, by whom such caverns were believed to be haunted." In the Scottish Highlands the peasants show you Wallace's Cave and Rob Roy's Cave; and at so

many different places, that one cannot but wonder at the ubiquitousness of those popular heroes. In Yorkshire, near Whitby, occurs Robin Hood's Cavern. But we might lengthen out the list until we had exhausted our readers' patience. Leaving these caves of historic, fictitious, or mythological interest, let us examine a few which are more remarkable in a physical point of view, either on account of their grandeur, formation, or beauty.

We need not travel beyond the limits of the British Isles for "wonderful caverns." The hills of Derbyshire, mostly consisting of limestone strata, present many curious examples. They are pierced with gloomy hollows, says Mr. Thorne, as if they had been rent and upheaved by some mighty earthquake. But the poet does not consider them "gloomy," for he lights them up with the lustre of his own fancies. "Oh, my beloved caves," he exclaims,

> ". . . . . From dog-star's heat
> And all anxieties my safe retreat!
> What safety, privacy, what true delight
> In the artificial light
> Your gloomy entrails make,
> Have I taken, do I take!
> How oft, when grief has made me fly
> To hide me from society,
> Ev'n of my dearest friends, have I
> In your recesses' friendly shade
> All my sorrows open laid,
> And my most secret woes intrusted to your privacy."

You see the poet here refers to those leafy hollows which open on the green hill-side, and are devoid of all sombre and forbidding characteristics. He would hardly find "a safe retreat" in the Peak Cavern, in Castleton Dale. This is, indeed, a magnificent scene. A vast mass of rock rises before the traveller. There yawns the mouth of the cavern, taking the outline of a depressed arch, 120 feet wide, 42 feet high, and about 90 deep. At the extreme end the roof becomes much lower, and a narrow passage is reached, where all daylight vanishes, so that the adventurous pilgrim must prosecute his further researches with a blazing torch. He has next to cross a rock-enclosed lake, very dark and still; and then enters a second great vaulted recess, 220 feet long, 200 feet broad, and in some places 120 feet high. Now comes another lake, where projects a pile of craggy rocks, popularly called Roger Rain's House, on account of the water which drips incessantly from the fissured roof. Beyond this, the pilgrim enters a third hollow, the Chancel, beautifully adorned with glittering stalactites. He then passes the Devil's Cellar, and Half-way House, and through three bold natural aisles, into another vast bell-shaped cavity, designated Great Tom of Lincoln. From hence the passage contracts in breadth and height, until it only

affords a channel for a small brawling stream. The whole length of the excavation is 2250 feet, and its depth from the surface of the mountain about 620 feet.

The remains of antediluvian animals—the extinct types of the animal life of the ancient world—have been found in some of these singular recesses. At Kirkdale, in Yorkshire, exists a cave, described as an irregular narrow passage, penetrating the hill-side for about 250 feet, in which Dr. Buckland discovered the bones of extinct species of hyænas, tigers, lions, bears, horses, deer, and the Siberian mammoth. The hyænas were of a great size; and from the number of their skeletons, and other circumstances, Dr. Buckland conjectured that, ages agone, this cave was the resort of a tribe of these fierce animals, which had dragged hither the other animals, particularly the oxen and the deer, as their prey, and had finally been destroyed by some great natural catastrophe.

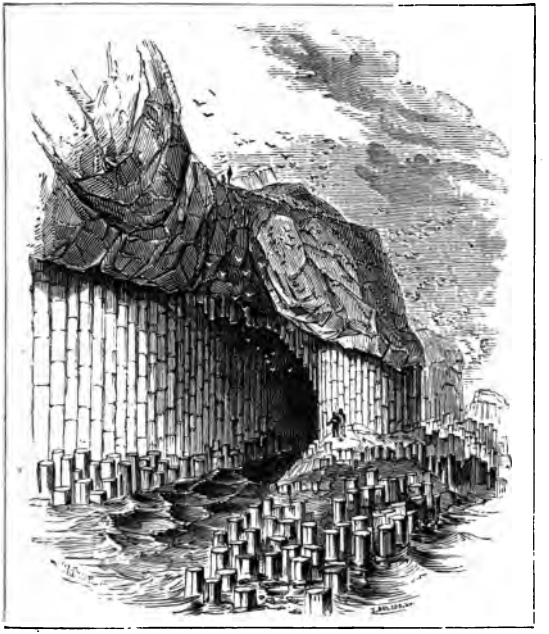
Another remarkable zoolithic cavern—as it is scientifically called—is Kent's Hole, about a mile from Torquay, in Devonshire. Its floor, first examined in 1824, was found to be plentifully stored with the fossil bones and teeth of animals no longer flourishing in this country—such as the bear, hyæna, rhinoceros, and elephant. Flint

arrow-heads, pottery, and other relics of human occupation, were also discovered. The entrance is about 5 feet, and the cave itself from 10 feet to 18 feet high, with a breadth varying from 2 feet to 70 feet. It may be explored for a distance of 650 feet, when a pool of water presents an impassable barrier.

Similar caves occur near Hutton, in the Mendip Hills; at Balleye, near Wirksworth; at Oreston, near Plymouth; on Dudham Down, near Clifton; at Yealm Bridge, in Devonshire; at Paviland, in Glamorganshire; and at Crawley Rocks, near Swansea.

One of the finest caverns in the world is Fingal's Cave, in the island of Staffa, on the western coast of Scotland—a grand and gorgeous excavation in the basaltic rocks, which here assume the appearance of regularly arranged columns, moulded into various fantastic shapes by the action of the waves. A mass of lava forms the floor or base, and upon it are reared two ranges of basaltic pillars. The roof is decorated with spirals of basalt. Depth of the cave, 371 feet 6 inches; breadth at the mouth, 53 feet 7 inches; height of the arch at the entrance, 117 feet 6 inches; depth of water, 18 feet, decreasing gradually to 9 feet. The echo of the waves fills this grand natural temple with a solemn, organ-

like harmony, which undoubtedly suggested its old Gaelic name, Llaimh-buin—the Cave of



FINGAL'S CAVE.

Music. There are two other picturesque cavities in the neighbourhood—the Clam-shell or Boat Cave, and the Cormorant Cave.

Let us now go abroad for a while in search of wonders. They are plentiful enough among the Alps, but we shall content ourselves for the nonce with a trip into the Bernese Oberland, where, near the Lake of Thun, and in the wild, grand valley of the Justis-Thal, whose walls of rock tower perpendicularly two or three thousand feet, lies the vast ice-cavern of the *Schafloch*, bored in the solid rock 900 feet above the level of the lake, and apparently inaccessible to human approach.

An English traveller once visited the Schafloch. Having accomplished the dangerous ascent of the mountain, he saw before him an antechamber, running some 70 or 80 feet back from the front of the precipice. The entrance might be 30 feet high by 40 wide, the roof rising internally like a domed vault, until another 20 feet was added to the height. "This natural vestibule," he says, "was sufficiently lighted from without to require no torch; but as we advanced inward, the gloom gradually deepened. On the left was the real cavern, or colossal hall, which I had come to see.

"Lighting our lamps, we commenced groping our way slowly and painfully over the sharp flint-like *débris* which constituted its floor. Mostly on hands and knees, rarely erect, we traversed this stony Slough of Despond, hoping

that every step would land us on level ground. Vain hope! only new obstructions, new difficulties, new perils, were to arise. At the extremity of the first plateau the ground made a rapid descent, not rough and rigid, not sharp and cutting, as hitherto, as though so many stilettoes were stuck handle downward in the ground, or the surface strewn with broken bottles, but smooth and glacial. In fact, at this line the region of ice began, and we had to descend the side of a cylinder, as it were, over which the water had been thrown—water which had been frozen as soon as it touched the surface. . . . . I must confess to a momentary hesitation, to a beating heart, to a nervous tremor, as we launched ourselves, like Columbus, upon this unknown, invisible sea of ice. It was, however, but a transient feeling. The decline was ventured, and in a few moments we were at the foot of this miniature precipice. Now opened upon us in the deep gloom a splendid scene. Not many feet beyond us blazed innumerable stars, which glistened like spangles or diamonds in the ebon horizon. Wherever the light of our lamps fell, a rainbow radiance illumined a little sphere, which twinkled and sparkled like the planets on a dark December night. From the roof to the ground, this brilliant galaxy of stars continued in a broken, but

not less beautiful chain. Place a piece of phosphorus in a rayless room, watch the pretty coruscations of the glow-worm on a sylvan bank in June, when the warm sun has long set; multiply the effect a thousandfold, and then you may conceive something of the witchery of the picture of which we were witnesses.

"We were now fairly in the interior.

"How shall I describe its magnificence? Many of my readers have seen stalactite caves, with their clammy, chalk-like pendants. But the recollection of these caves will afford only a faint conception of the scene I should like to pencil. From the roof the water had evidently oozed down from time immemorial. Its fall, however, had been arrested by an icy hand, even at the roof; as fresh streams from the rock above penetrated through and trickled over the congealed surface, icicles grew and grew until they reached the ground: but instead of falling perpendicularly to the floor, they formed outward and bent inward. Interlacing these props, as it were, of a structure built from the top, frozen bands or branches, which intersected each other, created the most perfect trellis-work, or, more properly speaking, the most delicate filigree-work. The result was a scene of real enchantment; and I seemed transported, as in a dream,

into the midst of an Eastern paradise. Kiosks, with innumerable minarets, or pavilions, or painted pagodas, or what you will, rose before me, vanishing away in the distance—all of the purest crystal. The scene might be described as a Gothic cathedral, the pillars in the nave being constructed of glass, and lit up from the interior; but even this similitude is faint and imperfect."

GROTTO OF ANTIPAROS.

A scarcely less magnificent spectacle is presented by the Grotto of Antiparos, one of the islands of the Grecian Archipelago. It is situated in a limestone formation, and like all limestone

caverns, is plentifully adorned with stalactites, or fantastic incrustations of calcareous matter. Its length is computed at 1000 feet. The principal cavern, which opens into numerous small recesses, is known as the Great Hall; and here, on a glittering stalagmite, called the Altar, 20 feet in diameter, and 24 feet high, the Marquis de Nointel, at Christmas 1673, caused High Mass to be celebrated with splendid pomp. The cave was illuminated by a hundred large wax tapers, and four hundred coloured lamps were burnt day and night.

Humboldt, in the narrative of his South American explorations, describes a curious work of Nature which occurs near Caripé, in the province of New Andalusia, and is called, from the nocturnal birds which flourish there, the Cavern of the Guacharo. In the face of a steep rock, covered with all the luxuriance of tropical vegetation, and festooned with creepers and climbing plants of graceful form and exquisite hue—with Bignonias and Solandras—is a vaulted arch, 80 feet in span, and 70 feet in height. A subterranean stream guides you into the recess, which for nearly a third of a mile preserves an average elevation of 60 feet, and is everywhere haunted by the guacharo, whose shrill cries rouse the echoes into a deafening din. The banks of

the stream, for forty yards, are adorned with immense heliconias and the Praga palm. It is scarcely possible to conceive a more remarkable scene than this huge cavern presents, with its crystal roof, its brawling waters, its noisy birds, and subterraneous grove!

Some caverns have been formed by violent volcanic explosions, others by the action of water on the primary strata. Humboldt classifies them under three principal heads:—

Thus, first, there are the narrow fissure-like caverns, which seem to have been suddenly rent in the solid surface of the earth; chasms comparatively narrow, but often of great length, and always of considerable depth.

Second, there are what might be called tunnel-caverns, fissures penetrating entirely through the rocks or hills in which they are formed, and open to the day at both ends like a tunnel. Martin's Hole, in the Tschingel Mountains, is a curious example. Twice in the year, at the equinoxes, the sun shines through it as if through a tube, and the valley beneath wears a peculiar but picturesque aspect.

And, third, there are caverns which consist of a succession of natural vaults or recesses, connected by more or less narrow passages, and often penetrating the earth to a considerable

distance. These are usually found in the limestone strata, and owe their fantastic aspect to the stalactites and stalagmites with which they are enriched. A *stalactite* is thus formed: the water trickling through the roofs contains carbonate of lime, held in solution by carbonic acid. A drop at last oozes through. The carbonic acid, being then exposed to the air, makes its escape, and an atom of lime is deposited. This process is continually in operation. Atom is added to atom, until a crystal is formed, varying in size according to the amount of lime deposited. The larger water-drops fall upon the floor, and the carbonic acid being disengaged, they rise upwards in continually increasing *stalagmites*, until both stalagmite and stalactite unite to form a natural column, resembling marble in its beautiful whiteness.

Before passing to another subject, mention must be made of the celebrated *Grotta del Cane*, a cavern in a hill near the Lake of Agnano, Naples. It has been famous since the earliest historic times for its malignant vapours; and Pliny speaks of it among those "*spiracula*"—*mortiferum spiritum exhalantia*—which emit a deadly gas. This is carbonic acid gas, which, owing to its gravity, accumulates at the bottom of the cave or cell, and is fatal to any small

animal. A dog is generally selected as the subject of the experiment—hence the name of the cavern. A viper, exposed to its influence, perishes in nine or ten minutes; but the old tales of slaves and captives who have been shut up in the grotto, and left to a miserable death, may be dismissed as fables. The upper part of the cavern is free from gas, which covers only the floor, and no individual need be afraid to enter.

Finally, reference must be made to the Grotta Azzurra, or Blue Grotta, in the Island of Capri, off the Italian coast. It is entered by a rocky arch, only three feet high, which forms a fit vestibule to the fairy palace, where surely the Nereids of the old mythology must have loved to disport themselves. The light from without enters the water, and being refracted upwards into the grotto, clothes every object in the most beautiful ultramarine hue. The cave is 165 feet long, with a maximum breadth of 100 feet, and height of 40 feet. The depth of the water is about 8 fathoms.

With these few examples of remarkable Caverns before him, the intelligent reader may next betake himself to the great Deserts of the world.

Among these he will not forget the dreary Landes of France, the treeless steppes of Russia,

or the stony tundras of Siberia. In the southern districts of Peru occurs a barren sandy tract of great extent, marked on the maps with the significant words, Zone of Perpetual Drought. No rain ever falls upon it—no gentle, fertilizing rain; and, consequently, it is neither brightened by leaf nor flower—it seems blighted with an everlasting curse. In Asia, between the Euphrates and the Tigris, stretches a region of almost equal sterility. Sand, sand, sand! Only relieved by an occasional clump of stunted bushes, or by a pool of briny water, whose taste is as poison to the thirsty traveller. It has been computed that Asia contains half a million square leagues of desert land—nearly equal to the whole area of Europe!

In Central Asia lies the barren tract of the Gobi, covered with a short, thin grass, and studded with brackish springs and lakes. The sands are loose and shifting, and the wind often drives them before it in huge billows of choking, blinding dust.

Further to the south, we find the Great Indian Desert, covering an immense space, nearly double the area of Great Britain, to the eastward of the river Indus. The whole region, however, is not absolutely barren; green valleys lie between the sand-hills, which yield scanty crops of grain

immediately after the wet season. But when the burning summer heats have burnt up the scanty vegetation of shrubs and grass which clothe the hillocks, the fine sand is scattered hither and thither by the wind, hills and valleys shift their relative positions, and the entire region sinks into a dreary waste, which only the camel can traverse in safety.

The Great Salt Desert occupies a portion of Persia and Afghanistan. It presents as desolate a scene as the wildest imagination could conceive.

The narrow basin of the Red Sea is the only boundary between the deserts of Asia and Africa. The African wildernesses commence on the coast of the Arabian Gulf, and extend right across the continent to the coast of the Atlantic. Between the Nile and the Red Sea stretches a high plain, intercepted by ranges of lofty mountains, and broken up by the rugged channels of winter-torrents, whose only garniture is a scanty strip of shrub, tree, and grass. Still drearier is the Libyan Desert, with its sun-scorched leagues of barren sand. It contains, however, four oases—the "islands of the Libyan waste"—depressions in the limestone surface, which, watered by small streams, rejoice in a moderate fertility, and are as welcome to the traveller as a safe harbour to the storm-tossed seaman.

Then comes the desert of deserts—famous from all time as the *Great* Desert—the Sahara, the Wandering Sea of the Arabs. It lies to the southward of the Atlas range; extends inland to Senegal and Lake Tchad; and, in the north-east, to the Mediterranean. Its average breadth is 1000 miles; its extreme length, from the Nile to the Atlantic, 3000 miles. With the exception of a few *wadys*, or hollows—"oases," as they are popularly called—which are brightened by small streams, the whole surface is sterile and blighted; not all sand, however, but in many places a barren region of black rock.

The Sahara forms a plateau of moderate elevation, averaging from 1000 to 1500 feet above the sea. About longitude 40° E., it is divided into two portions by the broad open valley of Fezzan, which wears an aspect of comparative fertility.

During the rainy season, from July to October, the hollows in the rocky table-land bloom with a scanty vegetation—acacias, ferns, grasses, shrubs, and an aromatic herb resembling thyme. Several salt lakes occur, and extensive beds of the purest rock-salt occur in the western division of the Sahara.

This great desert, as a glance at the map of Africa will show the reader, forms an almost impassable barrier between the northern and central

VIEW IN THE GREAT SAHARA.
(NEAR BIL-MA.)

regions; between the rich lands of Barbary and the no less fertile kingdoms of Uganda, Unyore, Senegal, and the countries recently traversed by Livingstone, Burton, Speke, and Baker. But for the camel—an animal fitted by its peculiar organization for long journeys over sun-blighted wastes—this vast waterless and sandy tract would be inaccessible to man.

To the reader it naturally seems that an immense wilderness like this—a wilderness blasted by excess of heat and light, without flowers, trees, or the sweet music of the waters, without any of those charms of scenery which lend such an inspiration to the poet's fancy—must be inexpressibly sad and pitiful; but the traveller finds it otherwise, and rejoices in its very wildness and sense of boundlessness. It is strange, remarks Captain Burton, how the mind can be amused amid scenery that presents so few objects to occupy it. "But in such a country," he continues, "every slight modification of form or colour rivets observation. Moreover, desert views are eminently suggestive: they appeal to the future, not to the past; they arouse, because they are by no means memorial. To the solitary wayfarer there is an interest in the wilderness unknown to Cape seas or Alpine glaciers, and even to the rolling prairie, the effect of continued

excitement on the mind, stimulating its powers to their pitch. Above, through a sky terrible in its stainless beauty, and the splendours of a pitiless blinding glare, the simoom caresses you like a lion with flaming breath. Around lie drifted sand-heaps, upon which each puff of wind leaves its own trace in solid waves, flayed rocks, the very skeletons of mountains, and hard unbroken plains, over which, he who rides is spurred by the idea that the bursting of a water-skin, or the pricking of a camel's hoof, would be a certain death or torture—a haggard land infested with wild beasts and wilder men—a region whose very fountains murmur the warning words, 'Drink, and away!' What can be more exciting? what more sublime!"

Such is the language of an enthusiast! Yet enough of it is true to convince an impartial judge that the Desert, like all God's handiworks on earth and sea, has its scenes of grandeur and its objects of high and fascinating interest.

AUTHORITIES.—Malte Brun, *Géographie Universelle;* Knight, *The Land we Live in;* Mrs. Somerville, *Physical Geography;* Tristram, *The Desert, &c.;* Captain R. F. Burton, *Journey to Medina and Mecca.*

III.

Glaciers and Icebergs.

"The ice was here, the ice was there,
The ice was all around;
It cracked and growled, and roared and howled,
Like noises in a swound!"

COLERIDGE.

IF the reader could transfer himself from the "cheery ingle," or the garden bower, where he is probably perusing these pages, to the snowy crests of the lofty Alps, how strange, how sublime a panorama would he see around him! He would stand in astonishment, as a German *savant* remarks, before that giant edifice of mountains, built up by powers whose origin and action can indeed be described, and whose relation to other powers can be explained according to the laws which science has deduced from the observation of natural phenomena, but whose whole extension and boundaries in the universe human knowledge can only dimly suspect. Far away in the clear, cold, sapphire sky,

in that wondrous azure which no cloud ever obscures, roll, like billows suddenly frozen and stiffened into rest, mountain upon mountain, clothed in a panoply of eternal snow. Below him the huge lammergeyer plies the labouring wing, and the chamois leaps from pinnacle to crag, and the sound of remote waterfalls occasionally breaks on the silent air; and far beneath him the mountain-flanks are hung with masses of deep forest-growth, musical with the song of birds;—but where he stands, on the lofty peak, no life shares with him the awful solitude, the intense silence; he looks above, and the heavens are still; he looks around, and from the Alpine heights comes no welcome voice; not a flower, not a leaf, not a blade reminds him of the sweet sylvan landscape and the happy meadows; the light falls upon the glittering snow and shimmering ice as on a vast sea of glass; and he feels as if he were brought face to face with the Infinite—as if he stood in the immediate presence of Divine Power!

Less sublime, but not less curious is the scene, if the traveller contents himself with making his way through the precipitous passes which afford an opening into this mountain region. Around, in savage grandeur, rise thousands of icy pinnacles and rocky peaks, which are scarcely ever

reached by human foot—scarcely even by the chamois. No philosopher has hitherto comprehended the laws of their confused and irregular accumulation; little is known of their fragments of a vegetable and animal world; but along their grim, gaunt sides, winds the noisy caravan of commerce. The braying post-horn echoes among their heights, and mingles its sounds with the ringing bells of the mules, and the voices of men speaking in many tongues. But by all this stir and tumult the Alpine giants are unmoved. With the glittering crown of eternity on their sacred heads, they continue their long, long sleep, dreaming, mayhap, of the ocean-waves which once dashed against them; of the colossal fire which upheaved them from the bosom of Earth; of the radiant molluscs and fishes that in the times of eld disported on their creeks and in their deep recesses;—then, how the waters slowly ebbed away; how the luxuriant blossoms and tapering palms of the tropics bloomed freshly on their summits; how, after a while, the chestnut and the lime hung their slopes with bright green foliage; and how, finally, all life sank down into the mysterious depths, the storms swept away the outer stratum of soil, the winters increased in length, and the summers stinted the welcome sunshine, until the snow, once all un-

known to them, yearly clung closer to their sides, crept up to their topmost peak, and mantled them in a mail of impenetrable brightness—and the Spirit of Winter reigned everlastingly on crests which had formerly laughed with the glory of a tropical vegetation! Perhaps, too, these silent giants—these mute warders of an inaccessible world—may be reflecting on the ruins of a more beautiful primeval state, which were turned into stone lest they should be lost; on the veins of glittering gold that run deep within their bosom, the beds of crystal that lie there unseen, and their hidden piles of radiant precious stones. But to the outward eye they seem dead—these mighty Alps! and every century buries them deeper in snow and under masses of ice, and crumbles away their naked ribs.

The most remarkable feature of these snow-clad mountains is, perhaps, their glaciers; those rivers of ice which accumulate in the hollow places of their rugged sides, above the snow-line, and descend into the valleys to a greater or lesser distance, sometimes thrusting their gaunt huge masses into the cultivated region. They derive their materials from the immense quantities of snow that, in summer as well as in winter, fall upon the crests of the loftier mountains. It is obvious that each fall of snow increases to some

extent the elevation of the mountain, which, accordingly, were no counteracting agents at work, would rise to an indefinite altitude. These agencies are the glacier and the avalanche. In the former, the snow descends with a slow, gradual motion, and changes into ice in its downward progress. In the latter, a mass of snow is loosened from its place by some sudden accident, and rushes with alarming velocity into the lower plains. The glacier is, in fact, a frozen river, whose consistency is greatest at its point of termination. It begins in snow, it ends in ice, which is distinguished by the purity of its colour and the minuteness of its crystallization. The pressure exercised by the falling snow expels the air, and closely compresses the particles of the inferior layers. This is the first stage of the freezing process. Then comes the second: the summer's heat melts the surface, and the water thus produced percolates, or drops through, the mass beneath, until it again congeals, and the whole becomes solid and durable as the rock. The French call the upper or snowy region of the glacier the *névé*. Of course, the increase of a glacier by snow falling on its surface is confined to that portion which is above the snow-line.

Above the snow-line? Yes; but, says the reader, what is the *snow-line?*

The limit, or boundary, on a mountain's side above which the snow never melts. This limit varies in elevation according to climate. In hot countries it is necessarily much higher than in cold, and the nearer we approach the equator the higher we find the snow-line, other conditions being equal. The reader may study the following table with advantage :—

HEIGHT OF THE SNOW-LINE ABOVE THE SEA-LEVEL.

[*Above this line lies the region of eternal snow.*]

Mountains.	Latitude	Eng. feet.
Spitzbergen	78° N.	..
Kamtschatka	59° 30′ N.	5,249
Altai (Asia)	50° N.	7,034
Alps	45° N.	8,885
Pyrenees	42° 30′ N.	8,950
Caucasus	43° 30′ N.	11,063
Rocky Mountains (N. America)	43° N.	12,467
Abyssinian Mountains	12°–13° N.	14,065
South Himaláyas	28° N.	15,500
North Himaláyas	29°–30° N.	19,560
Andes, Quito	Equator.	15,820
Arequipa, Bolivia	15° S.	17,717
Paachata, Bolivia	18° S.	20,079
Cordilleras (Andes), Chili	42° S.	6,010
At Strait of Magellan, S. America	53° 30′ S.	3,707

The glacier, then, is formed above the snow-line, though it occasionally descends below it. This calls our attention to the curious fact that these vast masses have a regular *motion*. The Alpine peasants had long observed that they moved with

more or less velocity, but the circumstance was not investigated by scientific men until within a comparatively recent period. To account for this motion various theories have been suggested, and by such eminent authorities as Charpentier, De Saussure, Agassiz, Rendu, Professor Forbes, and Professor Tyndall. The balance of probability lies between the two latter. It seems that the motion of the glacier is greater at the side than in the centre, at that side of the valley towards which it turns its "convex boundary." Professor Forbes, therefore, regards a glacier as an imperfect fluid or a viscous body, which is urged down slopes of a certain inclination by the mutual pressure of its parts. But the whole question is one of too purely scientific a character to be discussed in these pages.

You must not imagine, gentle reader, that the surface of these huge ice-rivers is as white and spotless as that of the snow in which they originate. The mountains that soar aloft on either hand are continually affected by the action of rain and frost, or the fall of avalanches, and, consequently, deposit their wreck and *débris* on the glacier beneath them, where the materials gather in two lateral ridges, sometimes thirty or forty feet high, which are termed *lateral moraines*. A quantity of earth and stones will be carried down

the glacier and piled up at its termination: this is called a *terminal moraine*. Where the glacier has withdrawn from the valley—the effect of a change of temperature—the terminal moraine appears as a waste of rock, a dreary and silent desert; and the lateral moraines will be found gathered in lofty ridges on the mountains which enclosed the great frozen river, testifying—as they do in many parts of Scotland, for instance—to its existence, and former position, in bygone ages. Sometimes two glaciers, or ice-currents, flow into another, like branch rivers into a main stream. The lateral moraines then unite into a central ridge, which traverses the middle of the trunk glacier, and is called a *medial moraine*. Finally, a mass of rock will sometimes fall on the frozen surface. In its shade the ice beneath will melt away, leaving the rock supported on a glittering icy pillar. This is called a *glacier-table*. When the glacier passes over a brow in its channel, or suddenly widens over a more extended area, an amount of tension is produced which causes the ice to crack, until a deep chasm, or *crevasse*, yawns right across its surface.

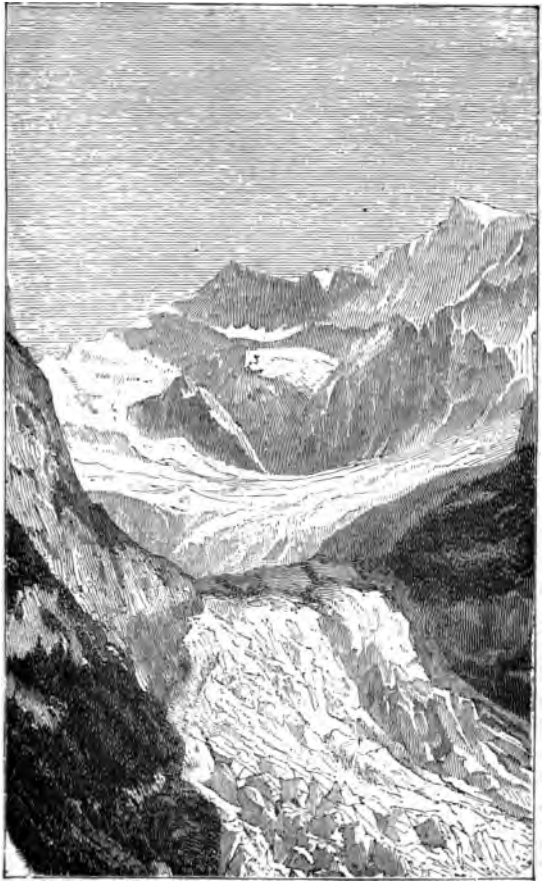
In Europe, glaciers are chiefly found in the Alps, and in the rugged snowy mountains of Norway. They are often of vast extent. In the

beautiful Alpine valley of the Grindelwald occur two immense glaciers, some twelve miles long, which have been aptly described as the branches of that mighty ocean of ice spread over the Bernese Oberland. In the area between Mont Blanc and the Tyrol occur fully four hundred glaciers—four hundred rivers of ice!—differing in magnitude and grandeur, but covering a total area of one thousand square miles. Their general aspect is that of a great body of water suddenly arrested in its descent, and congealed.

> "Torrents, methinks, that heard a mighty Voice,
> And stopped at once, amidst their maddest plunge!
> Motionless torrents! silent cataracts!"
>
> COLERIDGE.

The Grindelwald glaciers are rendered singularly picturesque by their contiguity to the green pastures and fir groves of the Grindelwald valley. There is something exceedingly striking in this descent of two vast streams of ice into the luxuriance of a rich pastoral and agricultural district. They issue from the bosom of the Eiger (giant) and Wetterhorn (tempest-horn), and are divided into two by the lofty peak of the Mettenberg (or middle mount).

The glaciers of Chamouni—a valley in Savoy, in the Pennine Alps—are, perhaps, superior in sublimity. The two most important are the Glacier des Bossons, and the Mer de Glace—the



GLACIER OF LOWER GRINDELWALD.

latter (sea of ice) being the largest and grandest in the Alps. From its lower extremity—called the Glacier des Bois—the meltings of the huge mass flow off in greater or lesser volume, according to the season of the year, from under a naturally-formed arch of ice, and swell into the Arveiron, a tributary of the rapid Arve. The Mer de Glace is the most extensive of the glaciers that furrow the southern flanks of Mont Blanc, and attains its grandest development at a point called Montanvert. Here a solitary rock, called *Le Jardin*, about seven acres in extent, and clothed in the finest herbage, forms a beautiful oasis in the midst of the sublimest desolation. And within a few paces of the glacier blooms the *gentiana major*, with its "flowers of loveliest blue."

The magnificent Glacier of the Rhone has been described by the poet Longfellow as "a frozen cataract, more than two thousand feet in height, and many miles broad at its base. It fills the whole valley between two mountains, running back to their summits. At the base it is arched like a dome; and above, jagged and rough, and resembles a mass of gigantic crystals of a pale emerald tint, mingled with white. A snowy crust covers its surface; but at every rent and crevice the pale green ice shines clear in the

MER DE GLACE.

sun. Its shape is that of a glove lying with the palm downwards, and the fingers crooked and close together. It is a gauntlet of ice which, centuries ago, Winter, the king of these mountains, threw down in defiance to the Sun; and year by year the Sun strives in vain to lift it from the ground on the point of his glittering spear."

The glaciers of the Himaláyan range are vast and magnificent. These "frozen cataracts" are also to be found in Tierra del Fuego, in Iceland, and Spitzbergen. Dr. Kane, the intrepid American explorer, discovered that Europe was united to North America by a huge glacier, which he named after the great German philosopher, Humboldt. The chasm between the Old World and the New is thus bridged over by the Almighty Hand, forming a scene of such awful grandeur that the most indifferent could not gaze upon it without emotion. The Humboldt Glacier is undoubtedly the largest in the world, and forms an impregnable barrier to Arctic exploration in that direction. It is situated in lat. 79° 30′ N., nearly.

When a glacier, as is the case in the Polar Regions, extends to the sea-shore, and protrudes its craggy brow into the wild waters, large

floating masses become detached, and form icebergs, ice-floes, and drift-ice. The sailors term this "the calving of the glacier," and the disruption takes place with a crash that is heard for many miles. These bergs, or mountains of ice, are frequently 200 or 250 feet above the sea-level, while fully seven-eighths of their whole mass are hidden beneath the waves! Fantastic in outline, they seem like glittering chalk cliffs, broken off from the mainland, and committed to the mercy of winds and tides. When freshly formed they wear a green or azure colour. In navigating the Polar seas the mariner is often exposed to great peril from these floating mountains. Sir James Ross, when voyaging in the Antarctic Sea with the two discovery-ships *Erebus* and *Terror*, met with a remarkable adventure. They were in latitude 60° S., and a thick shower of snow was falling. As icebergs were known to be in the vicinity, Sir James took every precaution that seamanship could suggest, and at last made arrangements for lying-to until daylight, deeming it too hazardous to run any longer.

Our people, he says, had hardly completed their operations when a large berg was seen ahead, and quite close to us; the ship was immediately tacked, with the expectation of being able to weather it. But, just at this moment,

the *Terror* was observed running down upon us, under her topsails and foresail; and, as it was impossible for her to clear both the berg and the *Erebus*, collision was inevitable. "We instantly hove all aback, to diminish the violence of the shock; but the concussion, when she struck us, was such as to throw almost every one off his his feet. Our bowsprit, fore-topmast, and other smaller spars were carried away; and the ships, hanging together, entangled by their rigging, and dashing against each other with fearful violence, were falling down upon the weather face of the lofty berg under our lee, against which the waves were breaking and foaming to near the summit of its perpendicular cliffs. Sometimes she rose high above us, almost exposing her keel to view, and again descended as we in our turn rose to the top of the wave, threatening to bury her beneath us; while the crashing of the breaking upper-works and boats increased the horror of the scene. Providentially they gradually forged past each other, and separated before we drifted down among the foaming breakers, and we had the gratification of seeing her clear the end of the berg, and of feeling that she was safe. But she left us completely disabled. The wreck of the spars so encumbered the lower yards, that we were unable

THE EREBUS AND THE TERROR AMONG ICEBERGS.

to make sail, so as to get headway on the ship; nor had we room to wear round, being by this time so close to the berg that the waves, when they struck against it, threw back their sprays into the ship."

By loosing the mainsail, however, they succeeded in extricating themselves from this dangerous position, though the lower yard-arms of their vessel actually scraped the rugged face of the berg! But another floating mountain was then seen directly astern of them, and it became a matter of no small difficulty to get the ship's head turned round and pointed fairly through between the two bergs, the breadth of the intervening space not exceeding three times her own breadth. This, however, was happily accomplished, and in a few minutes after, getting before the wind, away she flew through the narrow channel, between two perpendicular walls of ice, and the foaming breakers which stretched across it, and the next moment was in smooth water under the iceberg's lee.

We have alluded to the fantastic shapes assumed by these floating masses of ice. Some look like Gothic cathedrals, adorned with turrets, airy spires, and tapering pinnacles; others, like stately ships in full sail; and so exact is the resemblance, that instances are on record of boatmen rowing

up to them, in order to pilot the imaginary vessels into harbour!

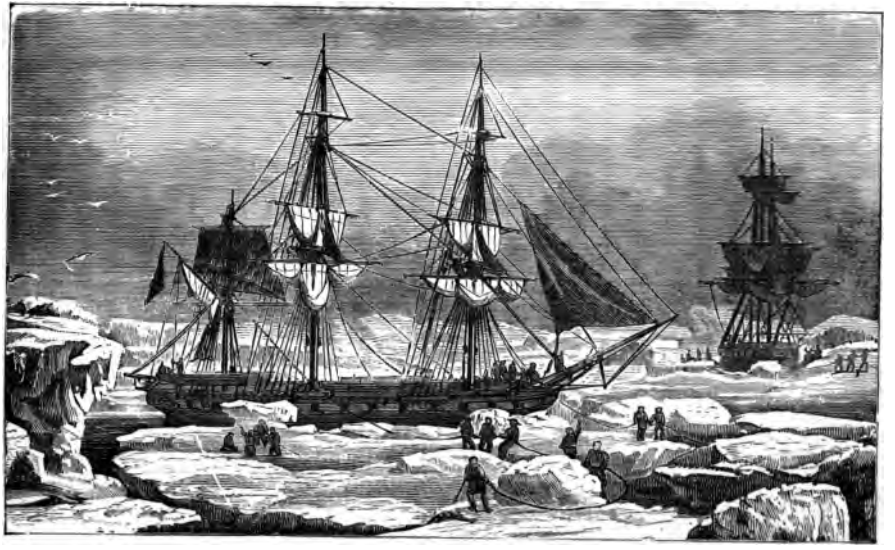
Others again may be likened to islands, agreeably diversified with hill and dale.

Twenty or thirty of them, says Crantz, may often be seen, after a violent storm, chasing each other in and out of Davis' Strait! Some of them frequently run aground in the shallow water near the shore, and remain there till softened by the continual washing of the waves, when they either fall asunder or are again driven out to the open sea, by the force of the tide and currents. Most of those that frequent the Arctic Sea are carried down into the latitude of Newfoundland and Nova Scotia, where they dissolve under the beams of the sun.

But even more formidable than icebergs is the flat floating ice—the ice-fields, or ice-floes, as the Arctic sailors call them. Some of these fields are said to be more than four hundred miles long, and in many places between one and two hundred miles in breadth! They lie so closely together, except where the wind and current have made an opening, that it is comparatively easy to leap from one piece to another; and the indented margin of one fragment corresponds with that of another, plainly exhibiting the marks of fracture. This kind of ice varies in thickness, but generally

averages fifteen or sixteen feet. It is brackish to the taste, being formed of sea-water. Ice-mountains of various dimensions are scattered over the mass, having been driven up the fissures by the wind and tide, to whose action they are necessarily more exposed than the level ice. With these appendages an ice-field displays the magnificent spectacle of "a well-peopled region, adorned with hills and dales, towns and villages, palaces, citadels, and towers."

A white glow in the air warns the seaman that he is approaching an ice-field long before the field itself is visible. But it is the smaller pieces that are most to be feared, as they float much more quickly, and, piled together by the wind and current, frequently rise above the vessel, which is sometimes thrown on its broadside, heaved aloft, or dashed into fragments. The whalers are often thus destroyed, though built much stronger than ordinary vessels. Such an accident happened to William Barentz, and Heimskerk, the great Dutch sea-hero, on their voyage of discovery in the year 1596–7. After wintering on the east side of Nova Zembla, in latitude 76°, they lost their ship in the ice, took to their boats, and sailed and rowed through the half-frozen sea for many hundred leagues, frequently attacked by the white bears, and sometimes compelled to drag



SHIPS IMPRISONED IN ICE.

their boat and its cargo for a considerable distance over the ice. They at length arrived at Kola, in Lapland, where they were taken up by a Dutch vessel.

From the Polar seas we return once more to the Alpine regions, to consider the nature and effect of Avalanches. These must not be confounded with the breaking up of an entire glacier; an event which, fortunately, is of rare occurrence, and always terribly destructive. The descent of the Gietroz Glacier, in 1818, into the upper Bagne valley, filled up the narrow gorge with ice to an elevation of 100 feet, dammed the river, and transformed a smiling valley into a perturbed lake. After a while the ice-barrier burst, and the waters poured into the lower valley, sweeping away houses, barns, and cattle—inflicting great misery—and causing a deplorable loss of life.

An avalanche is a mass of snow precipitated down the declivity of a lofty mountain. In some places these snow-slips occur periodically, and with so much regularity that their movements can be predicted almost to the day. It is otherwise with the dust avalanches (*Staub Lavinen*). These consist of snow, which, loosened and dried by a prolonged frost, and set in motion by the wind or by any accidental circumstance, suddenly

AVALANCHE.

swoops down the icy descent, increasing as it falls, and pours into the lower grounds in a broad deep flood. Its force is terrific: it tears up rocks and bushes, prostrates trees and houses, and suffocates men and animals. It causes by its velocity and magnitude a current of air like a strong hurricane, which bends the stoutest pine as if it were a reed, and plays with massive walls of stone as if they were the dead leaves of autumn!

A German writer gives an account of some of these catastrophes.

On January 14, 1719, the whole village of Leukerbad, with the exception of a few huts, was destroyed by an avalanche, which overwhelmed the houses beneath so incredible a mass of snow, that only a few of the inmates thus interred within their dwellings could work their way up to the day-light above. One man, named Stephen Roll, was immured for a whole week in the angle of a cellar, and could not break through his icy prison with his feeble strength. He sang aloud psalms and hymns in praise of God, and his voice was happily heard by some energetic diggers, who thereupon dug him out, and restored him to the blessed day. But notwithstanding every care, he died in the following week. Fifty-five human lives were destroyed by this avalanche.

In 1749, nearly the whole village of Ruäras, in the Grisons, was overwhelmed by an avalanche, which buried more than a hundred persons. As it fell in the night, when all were sleeping, many,

SNOW CRYSTALS.

whose houses were not ruined, or only gently thrust on one side, knew nothing of the terrible

accident, and only wondered on waking that the night was so protracted, until they discovered that they were imprisoned in a dungeon of snow! Some sixty of these were saved, either by their own exertions or the exertions of others.

On the other hand, we find recorded instances of some extraordinary escapes. In the Suabian War of 1498, four hundred Imperialist soldiers were carried away by an avalanche, and flung over a cliff; but, strange to say, the whole mass of snow became as full of life as an ant-hill, and, amidst shouts of laughter from the soldiers who had escaped unhurt, all the others crept out, a few slightly injured, but none fatally wounded.

Before quitting this interesting subject, it seems desirable to add a few observations on the composition of snow. All our readers know what snow *is*—namely, the atmospheric moisture congealed, when the atmosphere sinks to 32° or lower. But perhaps all our readers do *not* know that each flake is composed of beautiful crystals, usually in the form of hexagonal or six-pointed stars, and that of these Scoresby, Glaisher, and others, have discovered nearly one thousand varieties! Five principal genera, however, are recognized;—*thin plates*, the most numerous class, containing the most fanciful and exquisite forms; a *spherical nucleus*, adorned with spicular or

needle-like crystals; *six* or *three sided prisms*, of wonderful beauty; *six-sided pyramids;* and *prismatic crystals*, having at the ends and middle thin plates perpendicular to their length. The forms of the crystals in the same fall of snow generally resemble each other. The flakes vary from an inch to the 100th of an inch in diameter, and are smallest when a very low temperature prevails.

The pure white colour of the snow—a whiteness which is proverbial—is due to the combination of the different prismatic rays emerging from the minute snow crystals. A similar effect is seen in the foam of the "roused ocean."

The limit of the fall of snow is defined by the 30th parallel of north latitude, which includes the whole of Europe; in traversing the Atlantic, it rises to 45°; descends again on reaching the mainland; rises to 47° on the west of America; and falls to 40° in the Pacific.

AUTHORITIES.—The reader may consult Berlepsch, *Der Alpen;* Prof. E. Forbes, *Travels in the Alps of Switzerland and Savoy;* Prof. Tyndall, *Glaciers of the Alps;* Galton, *Vacation-Tourists;* Tschudi, *Nature among the Alps;* Dr. Hooker, *Himalayan Journals;* Dr. Kane, *Arctic Explorations;* David Crantz, *History of Greenland;* Captain, afterwards Dr. Scoresby, *Arctic Regions;* Sir James Ross, *Voyage of Discovery in the Southern Regions;* Rev. Mark Noble, *With a Painter in Search of Icebergs;* Humboldt, *Cosmos; &c.*

IV.

The Gulf Stream and Ocean Currents.

"The moon charms the watery world below,
Wakes the still seas, and makes them ebb and flow."
NATHANIEL LEE.

WHEN Columbus was essaying the discovery of a New World, his seamen, lacking the enthusiasm of genius and the confidence which springs from knowledge, grew weary and alarmed at the apparently interminable course of their adventurous voyage. Westward, and still westward, flew the rapid barks, and nothing could the dismayed eye rest upon but the sunlit heavens above and the rolling sea around. Or if a cloud-bank was seen in the horizon, their hopes grew warm and excited, for they thought it indicated the existence of the wished-for land. But as they advanced, the pleasing illusion faded away, and a wild waste of waters met their straining gaze. Their dejec-

tion daily increased, and at length ripened into a rebellious spirit, which was only checked by the courage and resolution of the great discoverer. Finally, Columbus persuaded them to continue their adventurous course for three days longer. And at sunrise, on the second day, says Lamartine, some freshly broken twigs appeared near the vessels. A plank shaped with the hatchet; a plank artistically carved by means of an edged instrument; a branch of hawthorn in flower; a bird's nest suspended to a bough torn from the tree by the wind, and filled with eggs which the mother still covered, undisturbed by the gentle undulation of the waves; floated successively upon the tranquil surface of the deep. The seamen eagerly collected these witnesses—written, speaking, or living—of a neighbouring land. They were the voices of the shore confirming that of Columbus. Before regarding the land with living eyes, he had inferred its existence from these eloquent signs. So straightway the discontented fell upon their knees before the admiral whom they had insulted on the previous day; they implored him to forgive their disobedience, and raised the loud hymn of gratitude to God, who had made them partakers of his triumph.

On the 12th of October 1492, the New World was first seen by these strangers from the Old

World, and a fresh chapter in the history of the human race was opened.

The plank, the twig, the bird's nest, that thus strangely confirmed the hopes and promises of Columbus, were brought within his ken by the agency of a remarkable current, or as Maury aptly calls it, ocean-river, which, starting from the coast of Mexico, flows through the Atlantic to the north of Great Britain, and thence descends along its eastern coast, everywhere spreading a happy and wholesome influence.

This current—this ocean-river, or rather this genial Power—is familiarly known as the *Gulf Stream*, and derives its name from the Gulf of Mexico, out of which it flows. At the commencement of its course, it has the high temperature of 88° 52′ Fahrenheit—that is, higher than summer heat—which gradually declines as it advances northward. If the reader will take a glance at the accompanying chart, he will be able to understand our description of its track.

In issuing from the Straits of Florida, it takes a north-easterly course along the American coast to the island and banks of Newfoundland. It is there turned to the eastward by the configuration of the land and the prevailing winds, and, after passing Newfoundland, by a cold current from Baffin's Bay, which greatly reduces its tempera-

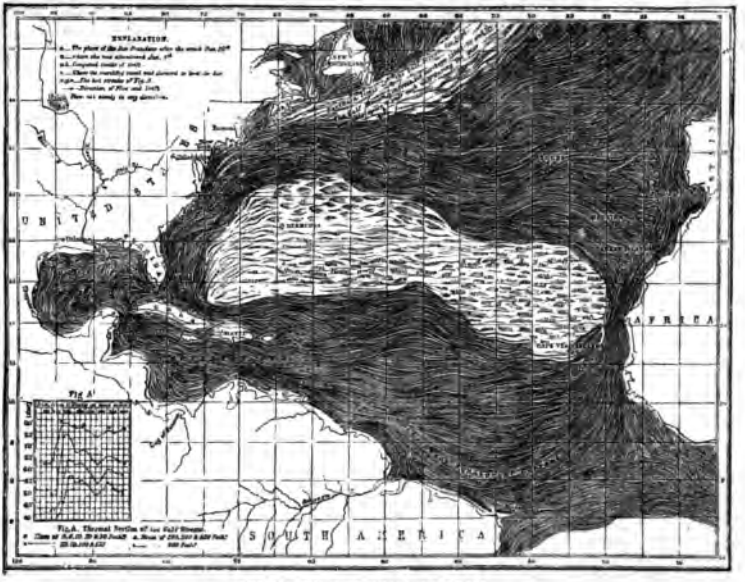


CHART OF THE GULF STREAM.

ture, for off the coast of Labrador its heat is only 75°. It now crosses the Atlantic, dividing into two branches, one of which raises the temperature of the atmosphere of southern Iceland some 17°, while the other washes the British Islands and the coast of Europe with waters heated by a tropical sun. Thence it proceeds towards the Azores, where it bends southward, and, aided by the north-east trade-wind, joins the great equatorial current, having made a circuit of 3800 miles with various velocity. In its centre, we may add, a vast area or loop of water, nearly stagnant, is thickly covered with sea-weed, and hence is known by the Spanish appellation of the *Mer de Sargasso*—the "sea-weed meadows," as old Oviedo called it.

The waters of the Gulf Stream are of a deep indigo blue, and their division from the green billows of the Atlantic is as strongly marked as the boundaries of a highway road from the grassy pastures which it traverses. A vessel will frequently sail these seas with one side laved by the blue waves of the Gulf Stream and the other by the green waters of the Ocean. Its warm current teems with myriads of fish and animalculæ, and it sweeps along with it immense masses of sea-weed torn from the coral rocks of the strait through which it rushes with its greatest swiftness. This

swiftness is computed at 78 miles a day. The stream broadens rapidly as it pours to the northward, until it diffuses its revivifying waters over a large surface of the ocean. And so considerable is the amount of warmth thus spread over the Atlantic in a single winter's day, that, if confined to the atmosphere of France and Great Britain, it would raise it from freezing point to summer heat! To its influence, in a great measure, are due the emerald verdure of Ireland, the bland soft airs that bless the south of England, and the general mildness of the climate of Great Britain. That we are spared the severe winters of Lapland and Russia, is owing, in fact, to the burning sunshine of the tropical world! England, whose vales and meadows are clothed in perennial beauty, and Scotland, whose wildest hills bloom with the sparkling heather, lie in the same latitude as the desolate and ice-bound plains of Labrador, and only escape a similar fate through the welcome agency of the Gulf Stream.

In mid-winter, off the rugged American coast, between Cape Hatteras and Newfoundland, ships beaten back from their harbours by strong north-westerly gales and currents, labouring with masses of Polar ice, will frequently turn their prows eastward and seek the radiant influence of this remarkable current. A bank of fog, rising like a

wall, and caused by the condensation of the warm air when it meets a colder atmosphere, marks its edge or boundary. The colour of the water suddenly changes from green to blue; winter gives place to joyous summer; and so striking is the change, that when a vessel is crossing its margin the look-out man at her bow will be enjoying a delightful warmth, while the steersman shudders and shivers with the cold. The difference of temperature is equal to 30°.

The Gulf Stream, however, is only one of the great ocean currents. These are of various extent, magnitude, and velocity. Some depend upon circumstances not less permanent than the globe itself, and others on causes which are as mutable as human fortune. *Constant currents*—to adopt an able writer's classification—are produced by the combined action of the rotation of the Earth, the heat of the sun, and the trade-winds; *periodical currents*, by tides, monsoons, and other long-continued winds; *temporary currents* arise from the tides, melting ice, and every gale of some duration. These vast marine streams maintain a perpetual circulation in the waters of the deep; they are sometimes superficial and sometimes submarine, according as their density is greater or less than that of the surrounding sea.

A constant exchange of water, so to speak, is kept up between the poles and the equator. The general level of the ocean *must* be preserved, and when evaporation carries off a considerable quantity of the water in the hot equatorial regions, cold currents flow down from the north to supply the void. As soon as the level of the polar seas is impaired, an equatorial current hastens to maintain the equilibrium; and this compensating movement is continually going on, affected only by the rotation of the Earth, which apparently deflects the polar currents from east to west.

Owing to the uninterrupted expanse of ocean in the southern hemisphere, the prevalence of westerly winds, and the tendency of the polar waters towards the equator, one great ocean current has its origin in the Antarctic Sea. Impelled by the prevailing winds, the waters flow in an east by north direction, and drive against the southern coast of America, where they divide. A small branch doubles Cape Horn; the main stream pours along the American coast, until, suddenly turning to the west, it is lost in the great Equatorial Current of the Pacific, where it crosses that ocean between the parallels of 26° S. lat. and 24° N. in a vast river 3000 miles broad! We find it interrupted in the north by the coast of China, the Indo-Chinese peninsula, and the great islands of

the Eastern Archipelago. Nevertheless, a part makes its way through these islands to join the great Equatorial Current of the Indian Ocean.

This second permanent current, impelled by the south-east trade-wind, maintains a westerly course between the 10th and 20th parallels of south latitude. As it approaches Madagascar it divides—one branch, running to the north-west, curves round the northern point of Madagascar, traverses the Mozambique Channel, and, uniting with the other branch, doubles the Cape of Good Hope—the Cape of Storms of the early navigators—and, under the name of the South Atlantic Current, skirts the west coast of Africa as far as the latitude of St. Helena.

Here it merges in the great Atlantic Equatorial Current, which flows westward, and divides at Cape St. Roque in Brazil. The principal branch strikes to the north with great force and swiftness, and, flowing through the Caribbean Sea, passes into the Gulf Stream. The other extends southward along the coast of South America, throwing off a small stream across the Atlantic to the Cape of Good Hope; which stream, after having made the circuit of the Atlantic, and keeping *outside* the South Atlantic Current just spoken of, passes away into the Indian Ocean, where traces of it, in the shape of fishes and animalcules

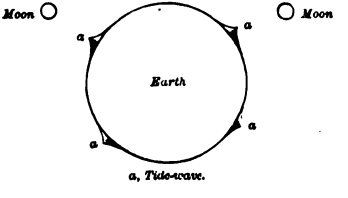
peculiar to its waters, are met with at a distance of 2000 miles from the Cape.

By a knowledge of these currents, and by skilfully taking advantage of their force and velocity, the seaman is able to accelerate his voyage from place to place.

These currents have been compared to rivers, but no rivers in the world approach them in magnitude. The Atlantic Equatorial Current is 160 miles broad off the coast of Africa, and, midway, measures in width between 500 and 600 miles. Its depth is proportionate.

A consideration of the currents of Ocean naturally leads us to an investigation of its Tides.

These are dependent to a great degree upon the attraction of the moon, and, to a lesser degree, upon the influence of the sun. Thus the area of ocean is elevated into great tidal waves, which keep time



a, Tide-wave.

with the attractions of these luminaries at each return to the upper and lower meridian; that is,

the *water* under the moon is drawn *from* the earth by her attraction, while, at the same time, the *earth* is drawn *from* the water diametrically opposite to her,—in both cases producing a tide of nearly equal height. This height depends upon the relative positions of the sun and moon, on their distance from the earth, and on local circumstances. Now, as the earth revolves on its axis in twenty-four hours, any point on its surface will be brought once *under* its surface, and once diametrically opposite. At each position it will experience the rise or protuberance of its waters—in other words, the tide will flow *twice* in the twenty-four hours, and about 50½ minutes later every day.

The tides are highest at *new* and *full* moon, because then both sun and moon are in conjunction, and exercise an equal influence; at the *first* and *last* quarters they are lowest, because the sun and moon are then at 90° distant, and counteract each other's attraction. The former are called *spring*, and the latter *neap* tides.

The great oceanic wave which twice a day washes the chalk cliff, the pebbly beach, or sandy shore of Great Britain, has occupied a day and a half in travelling from the place where it originated. It first strikes the west coast of Ireland and England, and then sweeps round the rugged

north of Scotland into the German Ocean, bathing the coasts both of England and the Continent, and finally entering the Thames, having accomplished the circuit of Great Britain in eighteen hours.

The reader will note the distinction between this great tidal wave, or general undulation, and the waves raised by the friction of the wind. The agitation at first extends little below the surface, but if the wind blows violently and for several hours, even the fountains of the great deep are troubled, and the billows rise higher and higher, until their "monstrous heads" seem to menace the mariner's destruction. On the coast of Africa, the huge waves, called rollers, which are almost perpendicular, attain the altitude of 50 feet! The highest waves of the Atlantic, according to the latest scientific research, measure—in height 43 feet; main distance between each wave, 559 feet; width from crest to crest, 600 feet; interval of time between each wave, 16 seconds; velocity of each wave per hour, 32½ miles.

Let the reader endeavour to picture to himself the spectacle presented by a succession of these tremendous billows sweeping along at a velocity equal to that of a fast railway train, their heads crowned with glittering spray and foam, their depths black as Erebus itself!

The violent commotion of the billows is confined to the particular area affected by the wind; but the ground-swell, which results from a long-continued gale, is transmitted through the ocean to regions far remote, until it either subsides from the friction of the water, or is checked by the resistance of land. In the latter case it dashes against the rocks in foam and spray, or rolls upon the shore in crested surf. Who, that has lived by the sea-side, is not familiar with the peculiar roar of the ground-swell? with the heavy *thud* of each wild wave as it breaks upon the beach? with its lingering, melancholy sound, like that of a distant death-bell? It is to this, surely, that Haliburton alludes when he speaks of "Ocean's surfy, slow, deep mellow voice, full of mystery and awe, mourning over the dead it holds in its bosom, or lulling them to unbroken slumbers in the chambers of its vasty depths."

During heavy gales on the coast of Madras, the surf breaks in nine fathoms water at the distance of four, and even four and a half miles from the shore. At such times no boat could live in it, and the largest vessels are compelled to cut their cables and run out to sea. The fury of the gale is sometimes so intense, as actually to subdue the heaving of the billows and scatter the surface in a heavy shower, called by sailors "spoon-drift."

SURF AT MADRAS

Its saline particles frequently impregnate the air to the distance of 50 miles inland. Even in fair weather the surf rises to a height of three feet at a distance from the shore of one hundred yards, and the natives pilot the voyager through it in boats called catamarans, which are specially constructed for the purpose. The boatmen are skilful, yet their skiffs are frequently capsized, and the passenger and his luggage treated to an unexpected immersion.

The rolling breakers on the west coast of Ireland are sublime—they frequently attain the height of 50, and even **150 feet**! At the back of the Isle of Wight the waves break in rough weather with tremendous force, and dash their spray against the chalky cliffs as if they would sweep away so puny a barrier.

Such are a few of the phenomena of Ocean. Who that contemplates them can refrain from a feeling of awe and wonder, an emotion of devout reverence, an overpowering sense of the wisdom and majesty of the Creative Mind? Not the heavens alone attest His greatness and declare His glory; but the sea also is His handiwork, and, in silence, we adore!

AUTHORITIES.—Humboldt, *Cosmos;* Mrs. Somerville, *Connection of the Physical Sciences;* Captain Maury, *Physical Geography of the Sea;* A. K. Johnston, *Physical Atlas.*

V.

Coral Islands.

"How pleasant were the songs of Toobonai,
When summer's sun went down the coral bay!
Come, let us to the islet's softest shade,
And hear the warbling birds!"

BYRON.

MOST boys are fond of poring over the wondrous narratives of the early navigators, and sailing with them, as it were, across the mysterious seas—seas studded by fairy isles and lit by a cloudless sun. Most boys, their fancy heated by these stirring records, dream to themselves bright day-dreams of remote islands, fringed with blue waves and crowned with palms, lying far away in the recesses of the Pacific. Playing the part of Robinson Crusoe under happier auspices, they build up the most delightful aerial castles in these oceanic Arcadias, and roam among luxuriant glades, which echo with the music of crystal streams, or hunt the goat in dense deep woods, whose trees are clothed with perennial foliage.

"Summer-isles of Eden lying in dim purple spheres of sea,"—their imagery comes back to the world-weary mind in after-life, and cheers it with a passing gleam of joy and beauty. How often, in the toil and strife of mature manhood, we long to realize these boyish visions! How we pine for the enchanted isle, where no anxiety should break the magic spell of happiness! How we desire to look out upon the sapphire sea, always reflecting undisturbed the glory of a tropic sky! How eagerly our heart listens for the music of the waters, for the haunting song of the breeze, for those sweet sights and sounds which none but the young and the poet can ever hope to enjoy!

It seems to us, even now, that of all books of voyages and travels, those are most attractive which relate to the Southern Seas and their picturesque archipelagoes. In the Coral Isle, with its blue lagoon, its encircling reef, and its smiling vegetation, there is always a fascination and a charm. And a peculiar interest, moreover, attaches to its formation, to its silent growth amid the waters, its birth and development under a tropic sun. All about it is fairy-like, weird, romantic, and effectually withdraws the mind from the dulness of every-day life. The Siberian desert impresses us with a sense of dread; the

rolling prairies distract us with the idea of immensity; there is awe, and not pleasure, in the contemplation of the ice-fields of the Polar World, and the huge volcanic fires of Hecla or Sumbawa; but in the Coral Island lives an undying mystery —lives an unfading beauty—and we delight in cherishing its image as a thing of loveliness and grace!

The islands of the Pacific are either of volcanic or coralline formation; in most cases, of both; the coral superstructure being raised on a foundation which has been thrown up by volcanic agency. And it is, as Mrs. Somerville observes, "a startling fact," that, generally, where there are volcanoes, the land is rising by slow and almost imperceptible degrees above the ocean; while, on the other hand, the vast spaces studded with coral islands, or atolls, are generally sinking below it, and for ages have been sinking.

Mr. Darwin, to whose researches on coral the scientific world is greatly indebted, distinguishes four different kinds of coral formation:—1. Lagoon islands, or Atolls; 2. Encircling reefs; 3. Barrier reefs; and 4. Coral fringes.

But before describing these, it may be as well to explain to our young readers what coral is, and how it is produced.

Coral, then, is the calcareous secretion or de-

posit of many kinds of minute polypes, possessing a general similarity of form and structure. They may be compared to a little oblong bag of jelly, with one end closed but the other open, and surrounded by tentacles or arms, usually six or eight in number, set like the rays of a star. Myriads

CORAL.

CORAL INSECT.

of these diminutive beings labour at the secretion of a common stony frame-work, which is called the coral or madrepore, and in whose minute orifices they reside; protruding their mouths and tentacles when under water, but withdrawing by sudden contraction into their holes as soon as they are molested or exposed to atmospheric influence. It was at one time believed that the corallines built up their structures from the very bottom of the sea; but it has been ascertained from careful observation that they cannot live at a greater depth than twenty or thirty fathoms; so that the innumerable isles which stud the Pacific and Indian Oceans must be based upon submarine mountains.

The polypes surround the layers which they secrete with a living gelatinous substance, just as the bark encircles the tree; and from this they project like buds, or, when their tentacles are expanded, like flowers. In the formation of a single coral reef, numerous species are usually associated, each occupying its own peculiar place. In the coral world none of that competition exists which causes the ferment and excitement of human careers! Corals of the branching genus *Porites* usually inhabit the exposed edge of the reef, and with them the *Mellipora complemata*—a species which form thick vertical plates united at different angles—are combined. In the stiller water within, more delicate kinds are at work; and in the placid depths beneath, brain-stone corals and beautiful flower-like forms tranquilly toil.

Age after age these tiny creatures labour; myriads die and myriads fill the vacant places; until, at length, the reef of coral rises to the surface of the water. But as soon, says Chamisso, as it has reached such a height that it remains almost dry at low-water at the time of ebb, the corals leave off building higher; sea-shells, fragments of coral, sea-hedgehog shells (*echini*), and their broken-off prickles, are united by the burning sun, through the medium of the cementing calcareous sand, which has arisen from the pul-

verization of the above-mentioned shells, into one whole or solid stone. This, strengthened by the continual throwing-up of new materials, gradually increases in thickness, till, finally, attaining to such an elevation that it is covered only during some seasons of the year by the spring tides. The heat of the sun so penetrates the mass of stone when it is dry, that it splits in many places, and breaks off in flakes. These flakes, so separated, are raised one upon another by the waves, at the time of high-water. The always active surf throws blocks of coral (frequently of a fathom in length, and three or four feet thick), and shells of marine animals, between and upon the foundation stones. After this, the calcareous sand lies undisturbed, and offers to the seeds of trees and plants, cast upon it by the waves, a soil upon which they rapidly grow, to overshadow its dazzling white surface. Entire trunks of trees, which are carried by the rivers from other countries and islands, find here, at length, a resting-place after their long wanderings; with these come some small animals, such as lizards and insects, as the first inhabitants. Even before the trees form a wood, the real sea-birds nestle there; strayed land-birds take refuge in the bushes; and, at a much later period, when the work has been long since completed, man

also appears, builds his hut on the fruitful soil formed by the corruption of the leaves of the trees, and calls himself lord and proprietor of the new creation.

"There, far below in the peaceful sea,
The purple mullet and gold-fish rove;
There the waters murmur tranquilly,
Through the bending twigs of the coral-grove.

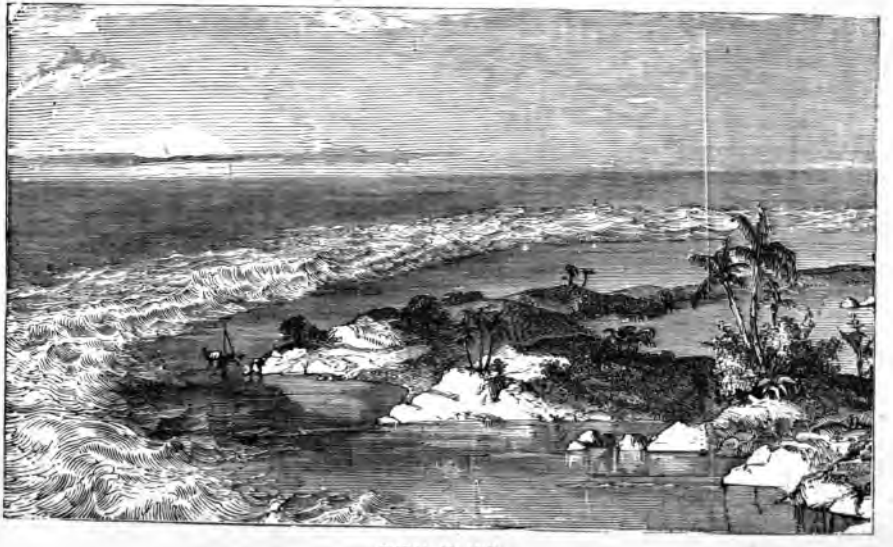
"There, with its waving blade of green,
The sea-flag streams through the silent water;
And the crimson leaf of the dulse is seen
To blush like a banner bathed in slaughter.

"There, with a light and easy motion,
The fan-coral sweeps through the clear deep sea;
And the yellow and scarlet tufts of ocean
Are bending like corn on the upland lea.

"And life, in rare and beautiful forms,
Is sporting amid those bowers of stone,
And is safe when the wrathful spirit of storms
Has made the top of the wave his own."

An Atoll, or Lagoon Island, may be described as a chaplet or ring of coral, enclosing in its centre a small lake or lagoon. Access to this area of still and beautifully transparent water is generally afforded by a navigable channel. The average breadth of that part of the ring above the surface of the sea is about a quarter of a mile, and its height varies from six to twelve feet. Hence, when not covered with a plume of cocoa-nut, palm, or pandanus, the atoll is not discernible, even at a small distance. On the outer or sea-

ward side, the ring shelves down to the distance of 100 or 200 yards from its edge, so that the sea gradually deepens to 25 fathoms, beyond which the sides plunge at once into those depths which no plummet has ever sounded, with a descent more rapid than that of any volcanic cone. On the windward side beats a tremendous surf, whose roar, audible at a distance of some miles, warns the mariner that he is approaching one of these lagoon islands. On the lagoon side, where the water is as calm as a mountain-pool, the reef shelves into it by a succession of ledges of living coral of more delicate and beautiful kinds than those which build the exterior walls and the foundations of the whole ring. The depth of the lagoon varies, in different atolls, from 20 to 50 fathoms, the bottom being partly detritus and partly live coral. Some few of the lagoons have been filled up by the increase of the coral; but as these corallines are of slow growth, and are preyed upon by many enemies, this is rarely the case. The coral is of the most varied and elegant structure, and of hues as beautiful as the fairest terrestrial flowers: dark brown, emerald green, sapphire blue, rich purple, rose pink, peach colour, yellow, with dazzling white, contrasted with deep shadows, gleam and glint through the transparent wave. The atolls are



CORAL ISLAND.

sometimes circular in form, but more frequently oval or irregular. Sometimes they are found in groups, sometimes solitary isles are scattered over the billowy expanse, but usually they occur in "elongated archipelagoes, with the atolls elongated in the same direction. The grouping of atolls bears a perfect analogy to the grouping of the archipelagoes of ordinary islands." In size they vary from 2 to 90 miles in diameter.

An excellent example of an assemblage of atolls, is the Dangerous Archipelago, lying to the eastward of the Society Islands. They are eighty in number; mostly circular, surrounding very deep lagoons, and separated from each other by profound straits. The reefs or rings are about half a mile wide, seldom peering more than ten feet above the edge of the surf, which breaks upon them with so loud a clash that it may be heard some eight miles distant.

The Caroline Archipelago lies north of the equator, and extends its atolls in groups, sixty in number, over one thousand miles. The most westerly portion is the Pelew Islands, made familiar to Englishmen by the shipwreck of Captain Wilson and the interesting history of Prince Lee Boo. They are finely wooded, but surrounded by dangerous reefs. Some of the Carolines abound in the useful bread-fruit; in

almost all, the pandanus, or screw-pine, thrives luxuriantly. The cocoa-nut is, however, the tree, *par excellence*, of the coral islands. Its groves agreeably diversify the landscape. Its uses are almost inexhaustible. It affords the islander a wholesome food; he thatches his hut, which he builds of its timber, with its spreading boughs; he covers his head with a bonnet made of its leaves; he fashions its nuts into goblets or bowls for his pipes; its fibres yield him fishing-lines and cordage; its juice congeals into a balsam to heal his wounds; and its fruit supplies an oil to anoint the bodies of his dead.

The Maldive and the Laccadive Archipelagoes are also assemblages of atolls, which are ranged in a double line, separated by a channel of immense depth.

Encircling Reefs differ in this from atoll reefs, that they have one or more islands in their lagoon. Such are the encircled islands of Hogolen and Siniavin; the ring that girdles the former is 135 leagues in circuit, and six or eight islands stud its lake-like central basin, which is so deep, and with so large an opening, that a frigate might sail into it. The Chagos Islands afford another instance; and so too does Tahiti, that queen of the Southern Seas, whose rare rich beauty has been extolled by every navigator. Rising in

mountains 7000 feet high, with a terrace of fertile land skirting their base, and their slopes densely covered with the luxuriant vegetation of the tropics,—it forms the central point of an immense lagoon, which is separated from the ocean by a coral reef, so as to form a channel twenty feet in depth, and varying in width from a half to three miles.

Barrier Reefs differ from the preceding in their position with regard to the land. They form a massive bulwark against which the ocean dashes in all its fury, but only to be driven pitilessly back. The barrier reef which skirts the north-east coast of the Australian Continent is the grandest coral formation in existence. It stretches along a line of 1000 miles, with a breadth varying from 200 yards to a mile, and at a distance from the shore which attains a maximum of 70 miles but seldom exceeds 30. Thus between it and the mainland lies a noble channel, varying in depth from 10 to 60 fathoms, and as navigable by ships as any sheltered river. There are a few passages from the ocean to this channel. The spectacle presented by the rolling of the Pacific against this stupendous natural bulwark is one of indescribable grandeur. The long ocean-swell, suddenly checked in its course as by an impassable barrier, rises up in one great continuous ridge of

blue water, which, curling over, falls on the edge of the reef in an unbroken cataract of dazzling snowy foam, and fills the air for leagues with a roar like that of distant thunder. New Caledonia is defended by a similar barrier reef, which surrounds the whole coast—both on the north and south—at a distance of from two to twelve miles. A continuation of the reef stretches fully 150 miles from the north-western point, or nearly to the Isle of Pines, and is dotted at intervals with islands, some of which are inhabited.

Coral Fringes are wholly unlike the preceding classes, because they are actually attached to the land, like a fringe, extending in many cases to a considerable distance seaward. The groups of the Navigators' and Sandwich Islands are conspicuous examples of these coral fringes.

We come now to the theory by which Mr. Darwin accounts for so many varieties in the aspect of coral reefs. The reader must please to suppose that, long ages ago, all the islands of which living coral forms a component part, presented the general appearance of a *fringing reef*, which, in the course of time, a gradual subsidence of land has converted into,—

1*st*, A barrier reef, in which the coral becomes

divided from the mainland by a channel of deep water; and,—

2*nd*, Into an atoll, or lagoon island, in which the enclosed land has become wholly or nearly submerged, leaving only the fairy-like ring of coral, with its lake-like basin within. If the enclosed land were mountainous, each peak would form a separate island in the lagoon, and the encircled islands would have different outlines, which the reefs would follow continuously.

These changes *have* taken place, and similar changes are *still* taking place; how rapidly, science has not yet been able to determine. There is reason to believe, however, that the speed with which Nature works in this direction is much greater than a careless observer would suppose.

> "Millions of millions thus, from age to age,
> With simplest skill, and toil unweariable,
> No moment and no movement unimproved,
> Lay line on line, on terrace terrace spread. . . .
> Atom by atom, thus the burthen grows,
> Even like an infant in the womb, till Time
> Delivers Ocean of that monstrous birth—
> A coral island stretching east and west."

AUTHORITIES:—Charles Darwin, *On Coral Reefs;* Wilkes, *United States Exploring Expedition;* Mrs. Somerville, *Physical Geography;* A. K. Johnston, *Physical Atlas;* Captain Beechey, *Voyage of the "Blossom;"* &c.

VI.

Cataracts.

"How profound
The gulf! and how the giant element
From rock to rock leaps with delirious bound,
Crushing the cliffs, which, downward worn and rent
With his fierce footsteps, yield in chasms a fearful vent
To the broad column which rolls on."

BYRON.

WHEN a river in its downward course accomplishes the rapid descent of a considerable precipice, the fall of waters thus occasioned is called a Cataract. No river can pass from a higher to a lower level without one or more such falls, unless its course is remarkably sinuous, and its progress very slow. The stream that traverses a rocky country—what geologists call a country of primary formations—is always distinguished by these swift descents; while if it flow through an alluvial district, its course will be serpentine and its channel comparatively deep, but it will flow with a soft and gentle current, free from any such obstructions as rapids or cataracts. Such is the character of

the Thames and the Severn, which make their way through rich alluvial grounds. The St. Lawrence, on the other hand, in crossing a region of primary rocks, indulges in the most tremendous leaps, and pours its mighty volume of waters over the most sublime heights. The early portion of the course of the Clyde is through a sandstone country, and hence it falls in a series of cascades of great beauty if of no very imposing magnitude: its lower course is through a fertile land of pasture and cornfield, and therefore its current is gentle, slow, and uniform. Cataracts communicate an impetus to the progress of a great river which is often highly advantageous; they deepen its channel, quicken its tide, and clear its bed from deposits of mud or sand.

A *Cataract*, then, is the descent of a river over a precipice which is almost or quite perpendicular; and its grandeur depends upon the volume of its flood and the height of its fall.

A *Rapid* is produced by the passage of a stream, with great swiftness, over a steeply inclined plane, but without any decided projection over a precipice.

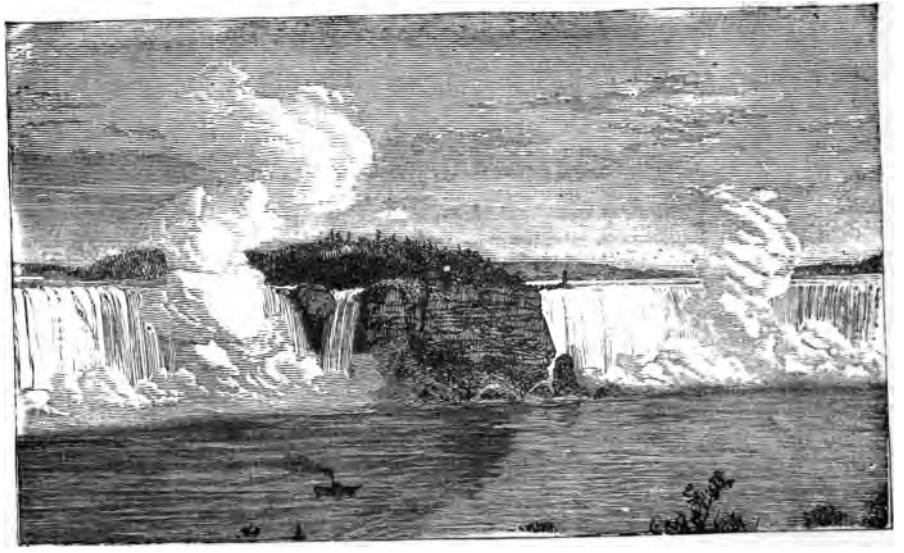
A *Cascade* may be described as a cataract on a small scale, and usually consists of two or more leaps. It is applied to the descent of a stream of comparatively small volume; but the term

"Falls" is now made use of both in reference to cataracts and cascades. Thus we speak of the Falls of Niagara and the Falls of Velino; though the former are sublimely magnificent, and the latter simply picturesque.

The Falls of Niagara form, indeed, one of the wonders of the world; a spectacle which no traveller can behold unmoved—can behold without an emotion of silent awe. Here the superfluous waters of four great lakes—or, rather, inland seas—after gathering in a channel thirty-three miles long, which extends from Lake Erie to Lake Ontario, suddenly hurl themselves in one mighty flood, and with a thunderous roar, over the brink of a huge precipice, falling beneath in a mass of foam and spray, lit up by a thousand rainbows. The cataract itself is divided into two unequal portions by the intervention of Goat Island, which has a front nearly 1000 feet in breadth. The fall on the British side of the river, called the *Horseshoe Fall* from its shape, is 2000 feet broad, and 149 feet 9 inches high. The reader who has seen the Thames at Gravesend has to imagine, therefore, that it is suddenly precipitated over a wall of rock only 50 feet lower than the Monument, if he would form an idea of the magnitude of this astonishing cataract. The American fall is 1140 feet broad, and 164 feet

high. The former, however, is far superior in sublimity to the latter. The flood of waters sweeps over the precipice with such fury that, in striking the stream below, it forms an arch, whose span is some feet from the base of the rock, and, consequently, the traveller may pass between the rock and the descending flood as through a vaulted gallery of crystal! The amount of water rolling over these falls has been estimated at 670,250 tons per minute!

We have spoken of the sublimity of the scene. A traveller, not wont to indulge in exaggeration of language, describes his impressions thus:— "So entirely," he says, "was I unprepared for the enormous volume of water, that, in the weakness of my comprehension and inability to grasp the scene, I was unwilling to turn my aching eyes from the glorious spectacle, apprehending it could only endure for a season, and that the overwhelming rush of water must speedily cease. But as I gazed with trembling anxiety, and marked no change beyond the masses of spray-clouds, swayed by the wind across the mighty sheet which ever retained its sublime proportions, the truth began to force itself upon me, that for thousands of years the waters had been falling, by day and by night, at all times and seasons, ever sounding, in a voice which, once heard, can never



FALLS OF NIAGARA.

be forgotten, the praise of Him who bade them flow. Here, indeed, may be felt the beauty of the words in our canticle, 'O ye seas and floods, bless ye the Lord; praise him, and magnify him for ever!' And it was probably with feelings of deep awe that the Indians of olden time, worshipping the Great Spirit, gave the peculiarly appropriate name O-Ni-aw-ga-rah, "The Thunder of Waters," to this matchless scene. It is indeed eloquent 'as with the voice of a great multitude; the voice of many waters; the voice of many thunderings, saying, Alleluia, for the Lord God omnipotent reigneth.'"

Mr. Charles Dickens's description does even fuller justice to the glorious scene:—

"When I felt how near to my Creator I was standing, the first effect, and the enduring one, instant and lasting, of the tremendous spectacle was peace;—peace of mind, tranquillity, calm recollections of the dead, great thoughts of eternal rest and happiness; nothing of gloom or terror. Niagara was at once stamped upon my heart an image of beauty, to remain there, changeless and indelible, until its pulses cease to beat, for ever.

"I think in every quiet season now—Still do those waters roll and leap, and roar and tumble, all day long. Still are the rainbows spanning them

a hundred feet below. Still, when the sun is on them, do they shine and glow like molten gold. Still, when the day is gloomy, do they fall like snow, or seem to crumble away like the front of a great chalk cliff, or roll down the rock like dense white smoke. But always does the mighty stream appear to die as it comes down, and always from its unfathomable grave arises that tremendous ghost of spray and mist which is never laid, which has haunted this place with the same dread solemnity since darkness brooded on the deep, and that first flood before the Deluge—light—came rushing on creation at the word of God!"

The roar of Niagara is sometimes audible at Toronto, a distance of 46 miles! It is noticeable, as a circumstance of geological interest, that a movement is annually taking place in its position—the cataract is receding higher up the river, through the erosion of the rocks, at the rate of three feet in a year, or, according to Captain Hall, 150 feet in forty years. If this estimate be correct, upwards of 35,000 years must pass away before the Falls can retire to Lake Erie, a distance of twenty-five miles.

Fatal accidents and hair-breadth escapes often occur at Niagara. A story is told of an Indian, whose canoe had through some chance been en-

tangled in the vortex of the current, springing to his feet when he found his fate inevitable, brandishing his spear, and singing aloud his war-song, as he swept on to death! A similar anecdote was recently related in the papers: the Indian, with the stoical composure of his race, threw himself down in his canoe, as if courting slumber, and so quietly passed away. Neither he nor his boat was ever seen again.

In South America the river Funza, on escaping from the confined valley of Santa Fe de Bogota —a basin shut in on all sides by lofty mountains —pours over a precipice 574 feet in height, and about 130 feet in breadth, throwing up a column of pearly vapour that is visible at Santa Fe, a distance of seventeen miles. At the summit and at the base of this precipice two different climates prevail, and the character of the vegetation also is entirely different. Above, the traveller wanders in the gloomy shadow of oaks and elms, and traverses a breadth of smiling corn-fields; below, he makes his way through the palms and bananas of the tropic world. Above, the air is fresh and cool and the breeze temperate; below, a sultry heat nourishes the luxuriance of leaf and flower peculiar to a torrid clime.

The Kaaterskill Falls, in North America, are remarkable for their romantic character. Their

waters issue from two small lakes in the Catskill Mountains, on the west bank of the River Hudson. The upper fall descends 175 feet; the torrent then rushes along a level for a rood or so, to leap over another precipice 80 feet high, into a deep dark ravine whose woody and rocky sides tower aloft to an elevation of upwards of 1000 feet.

On the Columbia River several cataracts occur of singular beauty. The current is strong and rapid, the bed of the river broken by immense crags and boulders, and the scenery on each bank possesses all that savage grandeur which belongs to the primeval forest.

Our European cataracts are inferior in magnitude and grandeur to those of the New World, but some of them are not less beautiful. The Falls of the Clyde, for instance, though on a small scale, exhibit those sylvan charms which the poet and the painter know so well how to appreciate. They are three in number—the Stonebyres, Corra Linn, and Bonnington Falls—of which the Corra Linn is the grandest. Here the river rushes over a declivity 84 feet high, into a sheltered basin hollowed out of the rock, whose sides are richly clothed with wood. As the bed of the stream is encumbered with crags, the waters now sweep through a narrow gulf with measureless violence,

now dimple into a tranquil pool, now whirl round and round in ceaseless eddies, and everywhere present some fresh point of beauty.

The most notable cataract in Europe is that of the Gotha, at Trolhetta, in Sweden. The river is the only outlet of a lake 100 miles long by 50 broad, which is fed by four and twenty streams. This huge volume of water falls in an unbroken sheet over a precipice seven fathoms deep, and then tumbles headlong into a mass of rocks, where it foams, and boils, and hisses; here, churning in a whirl of yellow spray; there, tossing like a shifting column of molten silver; but pouring onward over every obstacle, while it frets and champs as it goes, like a war-horse, increasing in rapidity and violence, until it finally dissolves in a sea of snowy froth!

In Italy the traveller is wont to make a pilgrimage to the Falls of Terni, which Lord Byron pronounced "worth all the cascades and torrents of Switzerland put together," and which in his *Childe Harold* he celebrated in noble verse:—

"Lo! where it comes like an eternity,
As if to sweep down all things in its track,
Charming the eye with dread,—a matchless cataract,

Horribly beautiful! but on the verge,
From side to side, beneath the glittering morn,
An Iris sits amidst the infernal surge,
Like Hope upon a death-bed, and, unworn
Its steady dyes, while all around is torn

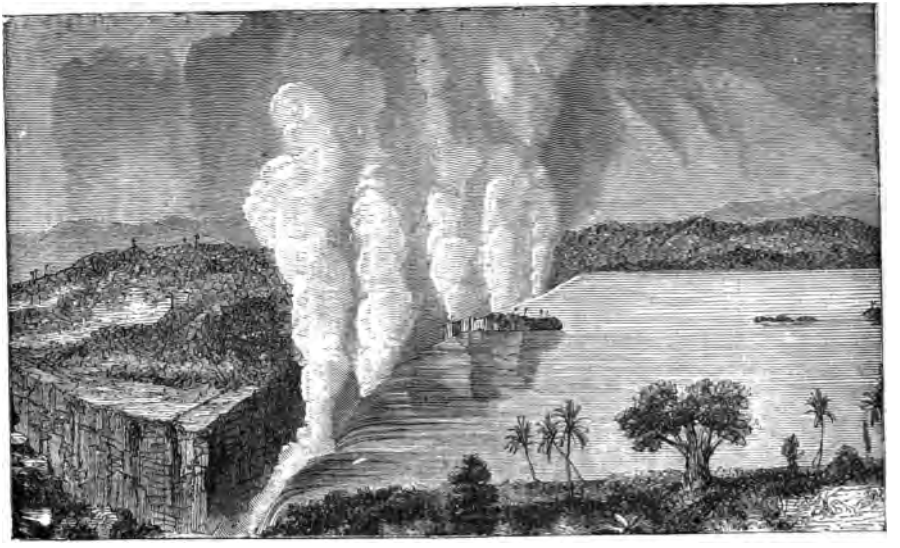
By the distracted waters, bears serene
Its brilliant hues with all their beams unshorn:
Resembling, 'mid the torture of the scene,
Love watching Madness with unalterable mien."

The Falls of Terni carry the waters of the Velino into the River Var by a descent of three stages—the upper is 50 feet perpendicular; the second upwards of 500; and the long sheet of foam, white as the driven snow, which forms the third, 240 feet.

At Schaffhausen the Rhine falls 70 feet, and its channel at this point is 450 feet broad. The scene is one of singular beauty, but scarcely equal to that at Handeck, where the Aar darts headlong down a precipice into a narrow and awful abyss, shut in by perpendicular cliffs. At right angles with it comes the beautiful Aerlenbach; and, half way down, the double cascade mingles into one. The Valley of Lauterbrunnen is famous in song for its "laughing waters" and sheeted cataracts; is it not, by name and repute, the Valley of Fountains only? Here is the beautiful fall of the Staubbach, where a small stream, descending 1400 feet, seems to vanish in a cloud of silvery dust! But the Swiss mountains are the home of the spirits of the cataract and the waterfall, and every river in its downward course leaps and plunges among the rocks with a wild and elf-like glee.

We might linger over this subject for many pages. We have not yet alluded to the giant cataract of the Victoria Falls, on the River Zambesi, which Dr. Livingstone has described so faithfully.

The scenery which surrounds these falls is described by Dr. Livingstone as very beautiful; the banks and islands scattered over the Zambesi being adorned with sylvan vegetation of great variety of form and colour. There flourish the mighty baobab, each of whose enormous arms would form the trunk of a large tree; the graceful palm, with its plume of foliage; the silvery mohonons; and the motsouri, rich in clusters of pleasant scarlet fruit. The falls are bounded on three sides by thickly-wooded ridges 300 or 400 feet in height, and may be likened to a flood of water, a thousand yards broad, hurled over a precipice of basaltic rock 100 feet in depth, and then suddenly compressed into a narrow gully of fifteen or twenty yards. "If one imagines," says Dr. Livingstone, "the Thames filled with low tree-covered hills immediately below the Tunnel, extending as far as Gravesend, the bed of black basaltic rock instead of London mud, and a fissure made therein from one end of the Tunnel to the other, down through the keystones of the arch, and prolonged from the left end of the Tunnel through thirty miles of hills; then fancy the Thames leaping



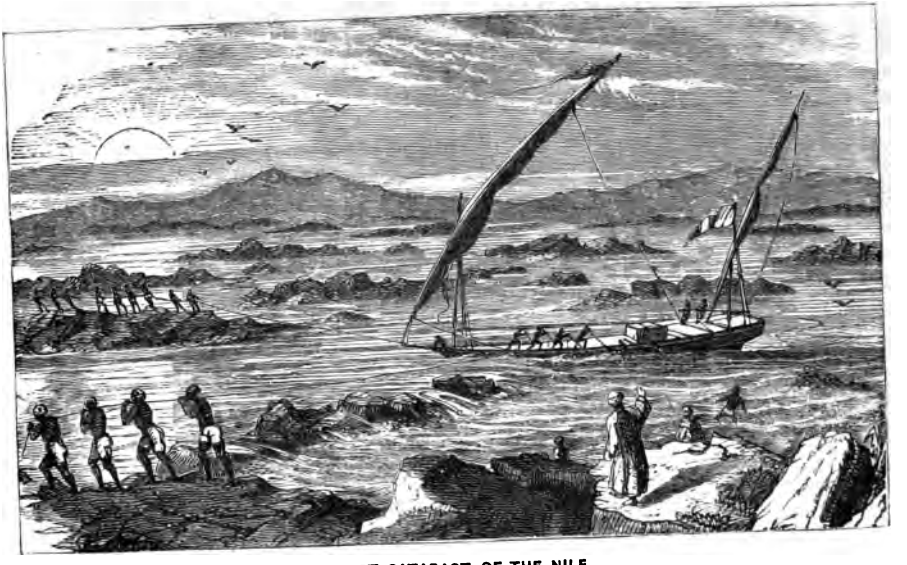
VICTORIA FALLS ON THE ZAMBESI.

bodily into the gulf, and forced there to change its direction and flow from the right to the left bank, and then rush boiling and roaring through the hills,—he may have some idea of what takes place at this the most wonderful sight I have witnessed in Africa."

In descending into the narrow abyss already spoken of, the cataract breaks into five separate streams, which send up, to an elevation of 200 or 300 feet, as many columns of luminous vapour—shafts of shivering spray and foam, which in the sunlight are gloriously wreathed with the rare hues of Iris.

The natives call these falls, in allusion to their vaporous clouds and thunderous roar, Mosioatunya —that is, "*smoke* does *sound* there." It was anciently called Shongwe; which appears to have meant a "seething caldron." Its columns of "smoke" are visible at a distance of five or six miles, and might lead an American traveller to imagine himself in the vicinity of a burning prairie.

Celebrated in story will be the Ripon Falls, so named by Captain Speke, which carry the young stream of the Nile, in a channel 150 yards broad, over a barrier of igneous rocks 12 feet high. There are scores of others, scarcely less interesting, which we cannot find room to particularize.



FIRST CATARACT OF THE NILE.

Speaking of the Nile, however, we may add a few details in reference to the cataracts which occur on its course through Nubia into Egypt. These are six in number, but are rather *rapids* than cataracts, in which no considerable descent is made, no sudden perpendicular plunge, but the stream rushes down an inclined plane, divided by the rocks into several narrow passages, where the waters rush with great velocity, forming numerous eddies and whirlpools. From the violence of the current, the ascent of the river is a matter of difficulty at these points, and the native boats are frequently swamped in their efforts to pass the first and most formidable cataract. Mr. Eliot Warburton furnishes an amusing narrative of his adventures on one of these occasions. The sheikh, who had charge of the passage of the river at this particular point, placed himself on a commanding rock, and encouraged his men with shouts, and prayers, and objurgations, to drag the boat up the ascent. An experienced pilot took his stand in the bow, and issued directions to the helmsman how to steer—what rock to avoid, what channel to thread; while a host of natives lent their efforts to overcome the resistance of the waters. And all was noise, and shouting, and excitement. Now the boat was threatened with destruction by an abrupt crag; now was menaced by a boiling eddy; nor

was it until after much vigorous toil that the passage was accomplished, the boat rode in comparatively smooth water, and the dusky labourers rejoiced exceedingly.

This first cataract is situated at Assouan, in lat. 24° 10′ N.; and the sixth, south-west of Mograt, in about lat. 19° 30′ N.

Such, then, are some of the Marvels of Earth and Sea; marvels which, as we have endeavoured to show, originate in natural causes, and are governed by well-known natural laws; yet marvels which do not the less eloquently testify to the wisdom and infinite power of their great Creator.

Lord Bacon observes, that "a little philosophy inclineth man's mind to atheism, but depth in philosophy bringeth men's minds about to religion: for while the mind of man looketh upon second causes scattered, it may sometimes rest in them, and go no further; but when it beholdeth the chain of them confederate, and linked together, it must needs fly to Providence and Deity." Therefore do we trust that the perusal of these unpretending pages may animate our readers to the cultivation of the natural sciences. And we are convinced that the more closely they study Nature—the more carefully they investigate its

mysterious agencies and admirable phenomena—the more critically they search into its varied and complex operations; the more visibly will they recognize the immediate presence of the Spirit which informs and quickens all this visible world; the more devoutly will they learn to appreciate the inexhaustible grandeur of the Mind which called it into existence; the more certainly will they know and feel that volcano, cataract, and earthquake — rolling billows and starry heavens—whatever the Earth possesses of truth, sublimity, or beauty—

"Prompt with remembrance of a present God!"

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